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MACHINERY

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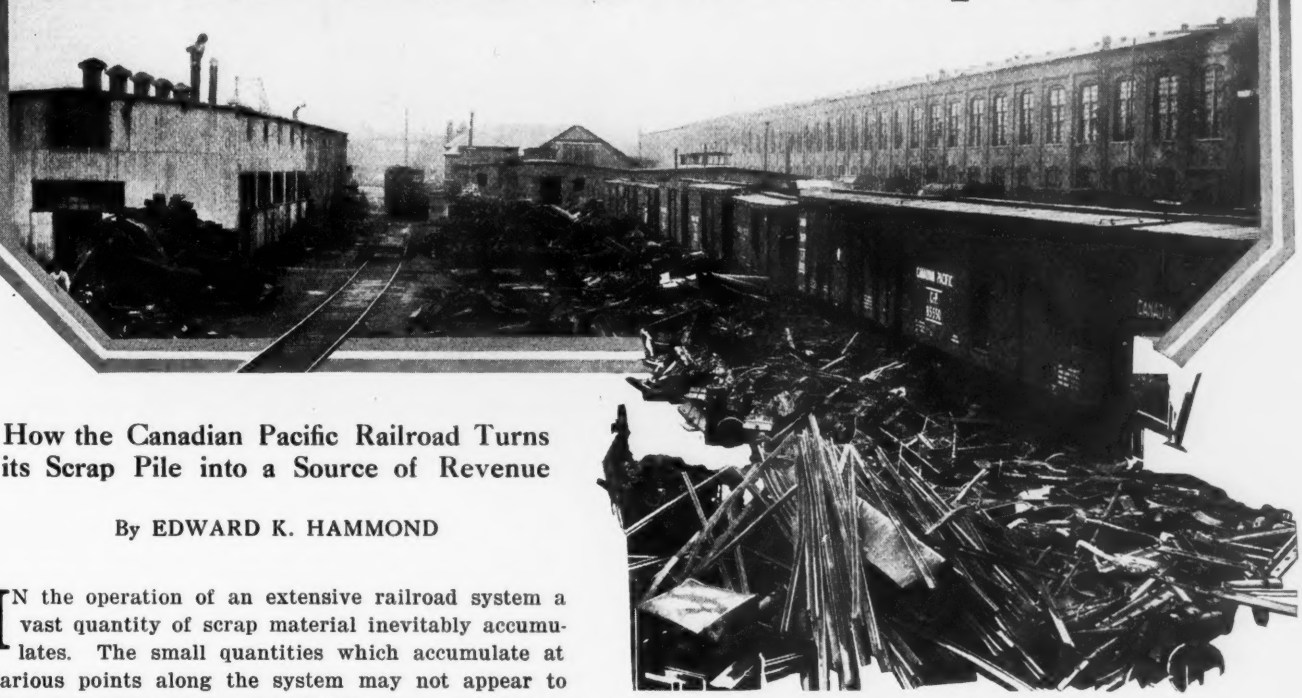
Reclaiming a Railroad Scrap Pile



How the Canadian Pacific Railroad Turns its Scrap Pile into a Source of Revenue

By EDWARD K. HAMMOND

IN the operation of an extensive railroad system a vast quantity of scrap material inevitably accumulates. The small quantities which accumulate at various points along the system may not appear to have any great value; but if this waste material is systematically collected and salvaged to the best advantage, the total saving is likely to prove higher than even the best informed men would think possible.

The way in which the Canadian Pacific Railway Co. gathers up scrap in that zone of its system served by the Angus Shops, and sends it to be reclaimed at these shops in Montreal will give an idea of the value of material which can be recovered from a railroad scrap pile. The magnitude of this work will be realized when it is known that at the time the writer visited the plant, there were approximately 7000 tons of scrap piled on the storage space adjacent to the reclaiming dock. This material is shipped to Montreal in freight cars, into which it is dumped without any attempt to sort it at the source.

Upon arrival, the contents of these cars are dumped on the storage grounds, and day laborers are set to work picking over the piles and sorting the material. A preliminary sub-division will result in the piling together of car couplings, brake beam heads, journal boxes, and various other parts which it may be possible to reclaim. Likewise, scrap rubber, broken glass, and other material of the same general nature, are sorted out and later prepared for sale as junk. As an example, armored steam hose is slit in order that the wire may be removed; then rubber and canvas is sold in that form. Scrap glass is packed into barrels for shipment, and in order to make paper more convenient to handle, it is compressed into bales of convenient size for handling. Fig. 1 shows a partial view of the storage space in which usable material is stored, after the contents of the junk cars have been sorted. The slitting of armored rubber steam hose is shown in Fig. 2.

Economy of operation is the great need of the railroad shop, as well as of all branches of industry, at the present time. Every source of waste must be eliminated—every leak must be stopped—if the great railway systems are to be brought back to a paying basis. One of the leaks in railroad operation is the scrap pile. Vast quantities of scrap metal and other waste material accumulate on an extensive railway system, and the transforming of this scrap into useful articles is one of the problems of efficient management. The reclaiming of the scrap pile requires a carefully thought out plan. How this is accomplished on a large Canadian railway system is told in this article.

Salvaging Bolts and Nuts—Reclaiming Steel Castings

A wide diversity of work is done in the reclaiming department. Many parts can be reclaimed or repaired, so that they can be used again. For instance, if bolts are in fairly good condition, it may be possible to simply rethread the end to adapt them for additional use, but if the bolt is badly bent or the thread is too far gone to lend itself to recutting, the end is sheared off and an entirely new thread is cut, thus making a bolt of shorter length. Similarly, old nuts are sorted for size and retapped to put them in condition for continued use. A special machine is provided for removing broken bolts from nuts. The work of reclaiming nuts is illustrated in Fig. 3.

Many of the malleable and steel castings that are returned to the scrap dock can be made fit for additional service. These castings are frequently cracked, and in such cases the defect is repaired by welding. In other cases the trouble may be due to bending, which is a defect quite often found in the shanks of car couplings. For correcting trouble of this kind, the shop of the reclaiming dock is equipped with several types of hydraulic and pneumatic presses which enable bent pieces to be straightened out in a comparatively short time. One

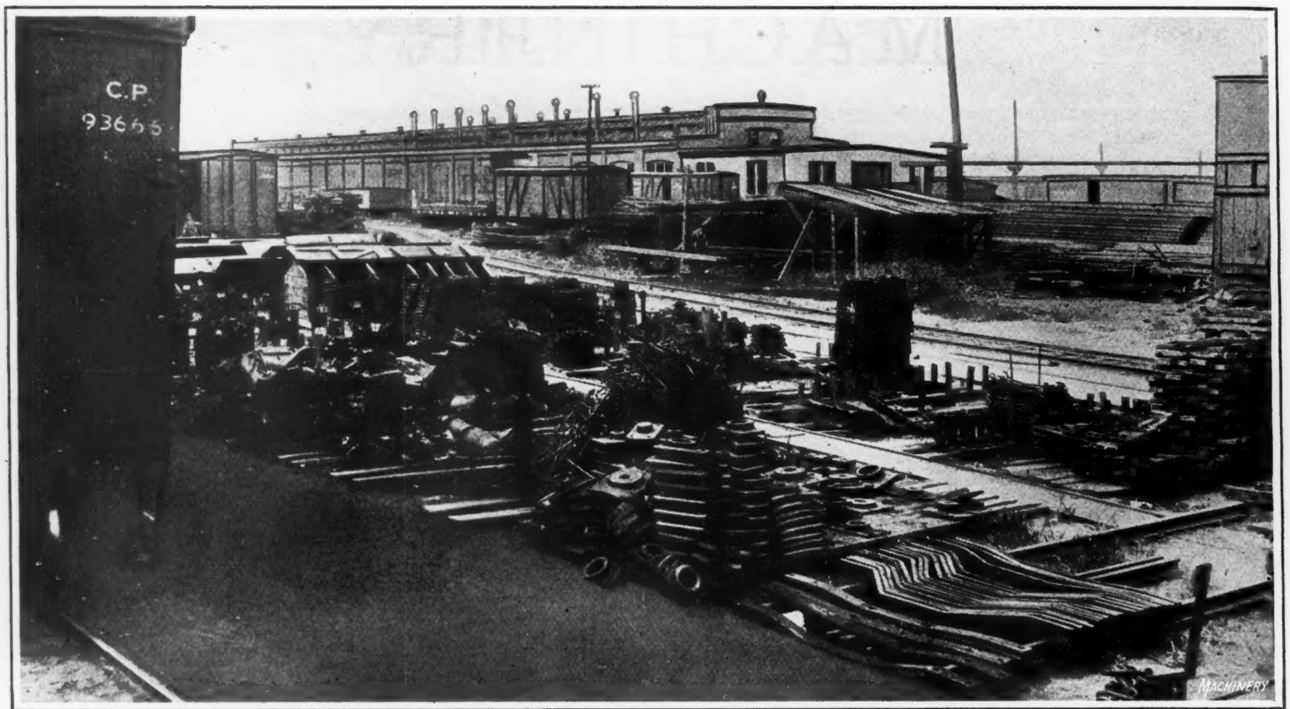


Fig. 1. Partial View of Storage Space in which Usable Materials are kept in Bins carrying their Part Numbers

of these presses is shown in Fig. 4, engaged in straightening the shank of a car coupling.

How Sheet Steel is Utilized

There are various forms in which sheet steel comes to the reclaiming dock; old shovels of various types are received, sheets of steel that have been scrapped after doing service in various ways, old wheelbarrow trays, etc. When the sheets are large, the oxy-acetylene torch is used to cut them up into sections of a size that may be conveniently handled. In the case of shovels the only thing necessary is to cut off the handle and remove the reinforced section that connects the handle socket to the bottom of the shovel. When this work has been completed, the steel goes to a power press equipped with a compound blanking die which is used for stamping out washers from the scrap sheet metal. This machine is shown in operation in Fig. 5.

Many of the shovels that come to the reclaiming dock have broken handles, while the bottoms are still good enough to be capable of giving a considerable amount of additional service. Conversely, the bottom may be worn out while the handle is in good condition. In addition to using the worn out shovel bottoms for washers, good shovel bottoms and good handles are collected together and refitted.

Methods Used in Reclaiming Steel Rod

In the material sent to the reclaiming dock, there are often considerable quantities of steel rod which is salvaged by either of two methods. In the case of rods of standard size, the procedure is simply to run them through a set of straightening rolls that put the rods into condition for subsequent use. Odd-sized rods have to be treated according to a different method, and the same practice is followed for the utilization of certain other classes of steel. In such cases, the material is heated and rolled out through a "three-high" type of rolling mill into rods of smaller diameter, the scrap material so treated being handled in exactly the same way as billets for hot-rolled steel rods.

Reclaiming Wiping Waste and Recovering the Oil

All railroads have occasion to use large quantities of wiping waste, and instead of following the usual practice of

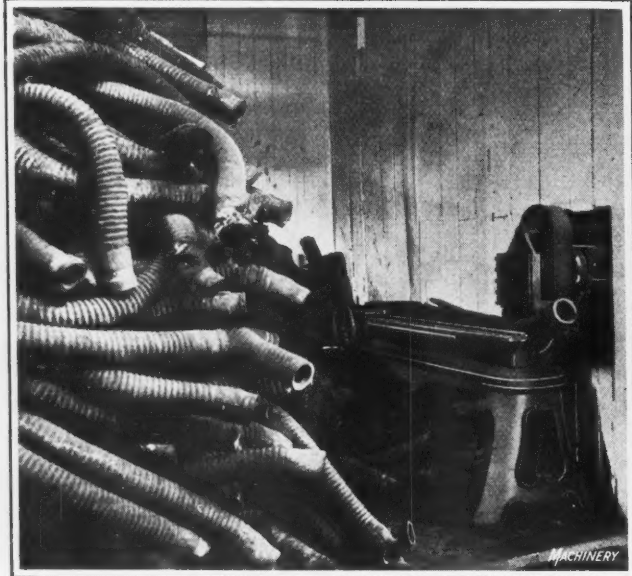


Fig. 2. Slitting Armored Rubber Steam Hose preparatory to removing the Wire

Fig. 3. Multiple-spindle Nut-tapping Machine used for rethreading Old Nuts

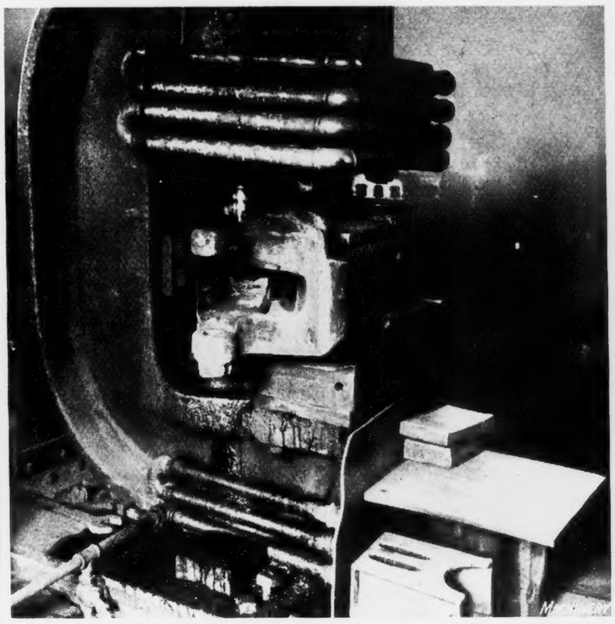


Fig. 4. Special Hydraulic Press used for straightening the Shank of a Bent Car Coupling

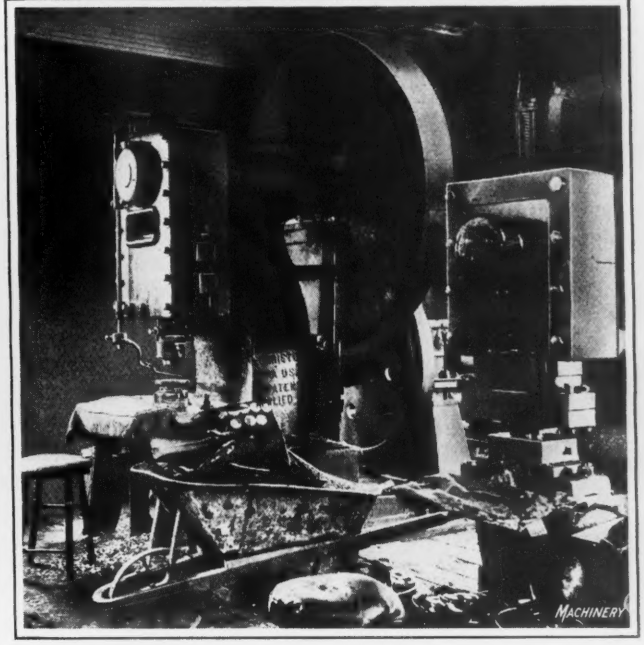


Fig. 5. Power Presses equipped with Compound Dies for piercing and blanking Washers

throwing this material away when it becomes too badly soiled for service, the C. P. R. shops in the zone served by the Angus shops collect it and send it back to these shops, where it is treated by a process that not only cleans the waste, but also recovers a considerable amount of oil. As the greasy waste first comes to the shop, it is placed in a centrifugal separator having a perforated bowl, in which the waste is held while the oil is thrown out through the perforations and caught in a suitable container. Next, the waste is cleaned in a washing machine of the same type as that used by laundries for washing clothes; and finally, the water is removed by subjecting the waste to a second treatment in a centrifugal separator.

Utilization of Scrap Pipe

Scrap pipe is utilized in a number of different ways, the two most important uses being in the construction of frames for farm crossing-gates, and in the making of pipe fitting nipples. In the case of the crossing-gates, it is simply a matter of cutting up the pipe into suitable lengths and threading the ends, so that by the use of couplings, elbows, and tees, a frame is constructed that will be covered with either wire mesh or strands of barbed wire. In using scrap pipe for making nipples, the procedure is quite simple: the material is worked through a pipe cutting and threading machine which cuts off pieces of the required length and threads the ends.

Resetting Spiral Springs

Large quantities of steel springs of various sizes come to the reclaiming dock. After a considerable amount of service, a compression spring often is flattened or a tension spring is drawn out too far to make it capable of fulfilling the required conditions. In the process of reclamation, the first step is to heat each spring and pull it out or subject it to a process of compression, according to the type of spring, after which it is retempered in order to give the steel the required physical properties.

Fig. 6. Accumulation of Scrap Sheet Metal outside the Tinsmith's Shop

How the Tinsmith's Shop is Supplied with Sheet Metal

One of the most extensive branches of the work of reclaiming scrap material at the Angus shops is carried on at the tinsmith's shop. In general no attempt is made to sort out the various classes of material prior to their shipment to the scrap dock. However, an exception is made in the case of the tinsmith's department, to which all sheet metal scrap from the different division shops of the C. P. R. system is shipped direct. A large supply of scrap metal is obtained from old brine tanks from refrigerator cars. The metal from both these sources is galvanized iron, and it is adapted for a variety of purposes. An accumulation of such material outside the tinsmith's shop is shown in Fig. 6.

Where lighter sheet metal is required, a considerable source of supply is obtained from old paint pails, all of which are shipped to Angus after their contents have been used. These pails are dipped into a tank of hot Wyandotte solution, which removes the paint and leaves the sheet metal clean and practically as good as new, without attacking the solder or otherwise affecting the surface of the metal. Some of these pails are cut up and used in sheets, while others are utilized by putting on a special cover and spout and making them into oil-cans of one-half gallon or one gallon capacity. Oil-cans of this type are shown at *R* and *T* in Fig. 7. This illustration also shows a variety of other products made in the Angus tinsmith's shop from scrap sheet metal, including water pans and pails, buckets, oil-cans, etc., the uses of most of which are self-evident. At *I* is shown a steam shield and at *K* a smoke-jack shield; *J* shows a car-heater top, *M* a smoke-jack, *N* a globe ventilator, *O* an engine-cab lamp shade, *P* a fireman's case kit, *Q* a tapered connection for a smoke-jack, *S* an engineer's tool-box, *U* a boiler inspection card-case, and *X* a car ventilator. The articles shown, however, by no means represent the entire range of products obtained as a by-product of the sheet-metal scrap pile.

Recovery of Solder from Joints in the Old Work

An important economy in the utilization of this scrap sheet metal is effected by the reclamation of all the solder used in sealing the joints. Obviously, all sheets of scrap metal that are utilized to advantage must be so cut that the seams carrying solder are removed. The scrap produced in this manner is sent to an oil-heated furnace where the metal is heated sufficiently so that the solder melts and drips through the grate bars into a pan. From this pan the solder is transferred to a refining furnace, where it is remelted in a pot from which the dross is skimmed off, leaving the pure solder in a condition to be cast into bars for subsequent use. In Fig. 8 is shown a view of the equipment used for this purpose.

Fig. 7. A Variety of Articles produced from Scrap Sheet Metal

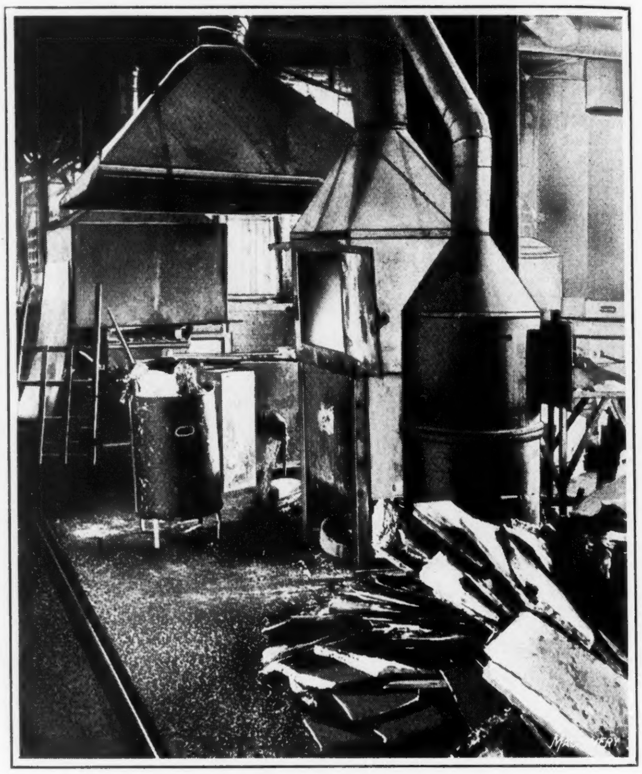


Fig. 8. Furnaces used for the Recovery of Solder from Sheet Metal

The value of material recovered at the reclaiming dock has run as high as $71,000 a month. With such savings as this possible, railway executives would do well to ascertain the possibility of applying a similar system for the recovery of all valuable material from the scrap that is produced in the operation of their own shops and in the maintenance of their lines and rolling stock.

* * *

SPANISH AUTOMOBILE INDUSTRY

The Hispano-Suiza Co., which is by far the largest of the three principal automobile manufacturing companies of Spain, has a total annual production capacity of about 2000 cars according to a recent Commerce Report. This company is located in Barcelona, but also operates a factory at Guadalajara for making trucks and various kinds of motor vehicles for the Spanish army. The Elizalde and the Espana automobile companies which are next in importance are also located at Barcelona.

According to Department of Commerce Reports, Spanish factories, as a rule, build only the engine and body of motor vehicles, importing the chassis and using foreign makes of carburetors, ignition, lighting, and oiling systems, etc. It is also stated that in the Spanish automobile field the United States unquestionably holds first place. The number of American-made automobiles in Spain today exceeds the total of all the other cars put together, including those made in Spain. Trucks of German and French manufacture, however, showed a decided gain in the Spanish market during the past year. Official statistics indicate that of the motor trucks imported into Spain during the first nine months of 1920, about 40 per cent came from France, 30 per cent from Germany, while only about 4 per cent came from the United States.

Changes in Patterns that Facilitate Molding

By M. E. DUGGAN

CHANGES in the design of a pattern can sometimes be made which will result in simplifying the method of molding, decreasing the cost of the work, or increasing production. An example of a change of this kind which materially increased the production of castings is shown in Fig. 1. The pattern is for a pouring basin, and the illustration shows the changes that were made to facilitate the production of castings. The patternmaker should realize that it is not always necessary to follow the design exactly;

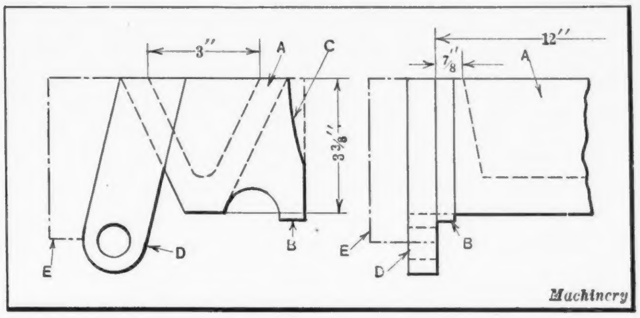


Fig. 1. Pouring Basin Pattern, showing how Improvements in Design simplify Molding

if simple changes can be made which will be of assistance in the molding work and will not affect the product, these changes should be made. If a pattern is to be molded in green sand, it may cause the molder considerable trouble in making the mold and in extracting the pattern, or if the mold is to be made with the assistance of dry sand cores, the extra cost of making these cores and the work of setting them in the mold may make it necessary to employ a different method.

In the present instance, sixteen sizes of pouring basins of various lengths were to be made from gray iron. The basin proper *A* is V-shaped and has a 3/16-inch radius at the bottom on the inside. This point in design would not have materially affected the method of molding if only a few castings were required, but when a number were to be produced the difficulties caused by this small radius made the pattern entirely impractical and the molding method slow and unsatisfactory. The time required to secure the thin edge of hanging sand in the cope and the possibility that it would drop or be washed away by the molten metal were factors that made it desirable to change the pattern.

First a change was made in the method of molding and then the design of the pattern was changed. In the first change the pattern was used as a core-box for making a dry sand core, which was suspended from the cope face of the mold. This method produced a good casting, but it resulted in a loss to the foundry owner. The second change consisted simply of increasing the size of the radius at the bottom of the basin to 7/16 inch so that it could be molded in green sand as was originally done. The sand was supported in the cope and secured by small pieces of wood. By this simple change the casting could be produced economically and satisfactorily.

These basins had a leg *B* cast at each end, having a graceful curve as indicated at *C* where the leg joined the body of the casting. This design necessitated making the legs loose and pinning them to the pattern, to avoid a deep parting and heavy "cope lift." This design was rejected by the foundry, and the pattern was returned to have the loose pieces secured to the pattern and built out in a straight line as indicated by the dotted outline so that the parting could come in a straight line and the pattern be readily drawn.

A hinge piece such as shown at *D* is also cast at each end of the basin which, in the original design, was intended to be molded in green sand. The slight change made to simplify the molding of this hinge was the use of a dry sand core placed at each end of the mold as indicated at *E*. A standard core-box was made for the hinge core, which was rammed up with the pattern in the mold. After the mold had been finished, it was a simple matter to remove the dry sand cores and draw the pattern without danger of injuring the mold. The cores were then returned to their place in the mold and the cope closed. The alterations here noted were later incorporated in the design of the pattern without affecting the usefulness of the casting.

Improvement in Molding Method

The casting shown in Fig. 2 was intended to be produced by a certain molding procedure, but it was found that by making slight changes in the method of molding, it was possible to produce it more economically. The pattern was originally made in two pieces, allowing 10 inches to extend into the cope and 16 inches into the drag. The intention was to mold the 1¾-inch slot in green sand, since the slots were cut from the pattern, but the molder realized that if this procedure were followed there would be a heavy body of sand hanging in the cope which would require the provision of sand-bars in the cope flask, extending down nearly to the parting line. It would probably have been necessary also to employ gaggers in order to help secure this deep body of sand and prevent it from dropping when the cope was closed.

The changes made by the molder were as follows: He fastened the two parts of the pattern together and made provision for molding the entire pattern in the drag. The pattern was made use of as a core-box to make a core which would extend down to the ribs *A*, and the core was placed

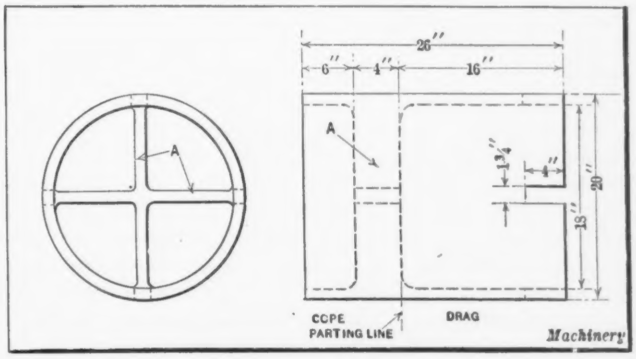


Fig. 2. Casting which was produced more economically through a Change in Molding Methods

in the pattern and made part of the cope by suspending it in the flask, using wire fastened to wooden bars placed crosswise on the top of the flask. This permitted the dry sand core to be lifted with the cope. In ramming up the drag, the four slots already made in the pattern were utilized for locating dry sand cores by means of which these slots were molded. The pattern was drawn out of the drag and the mold finished in the usual way before returning the cope with its hanging dry sand core to its place on the drag. It should be noted that the casting is molded on end, instead of horizontally, as shown in the illustration.

Simplification in Design of Patterns

It is frequently advisable when making castings for replacement, as in repairs, to simplify the design of the pattern in order that the repair part may be molded more quickly. Original designs usually have certain graceful outlines which are not necessary as far as service is concerned, so that when a casting or two is wanted for repairs, certain changes may be made (if a new pattern is required) which will enable the foundry to make the casting without any unnecessary work. A case of this kind is shown in the illustration Fig. 3.

The casting to be replaced was a journal bearing, 15 inches in diameter, provided with anchorages for the babbitt lining. An inspection of the partial section view at the left in the illustration will show that the finished strip at the top of the casting, the pads around the bolt holes and certain other features of design require the use of dry sand cores and other molding work which does not lend itself to rapid production. The view at the right shows the changes in design that were made and how they simplified the production of the casting. In this particular case the patternmaker was empowered to use any means that he felt advisable to produce the casting in the quickest possible time. This privilege

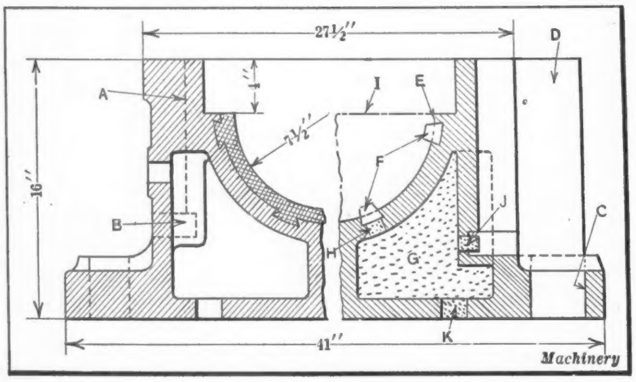


Fig. 3. Casting before and after changing the Design of the Pattern

is not always granted the patternmaker without first consulting the engineering department; but in a repair shop, where the regular manufacturing routine is not so rigidly adhered to, when the patternmaker has that liberty, changes will often be made which will simplify both the design and the molding.

Referring to the changed pattern, it will be seen that the finish strip and pads have been removed and the side of the bearing made straight; also that the bolt slot *A* has been extended and the cored opening *B* for the bolt head located on a level with the pads which surround the bolt hole in the base of the casting. This permits the use of one core for molding the bolt slots, the bolt head slots (of which there are two on each side), and the slotted clamping bolt hole *C*. This core was located in the mold by means of the core-print *D*. Provision was made for molding the babbitt circle *E* in dry sand by loosely attaching core-prints, as at *F*, to the pattern and using the pattern in this condition as a core-box for making the dry sand core *I*. Anchor cores, as shown, were then set into the slots produced in the bearing core at *F*, and pasted in place for producing the anchorage slots for the babbitt.

Provision for locating and supporting the water-chamber core *G* in the mold and for liberating gases was made in the following manner: Stud cores *H* were set on the anchor cores, and other stud cores *J* were located in a hole formed in that section of the main core by which the bolt head slot was produced. This provided the necessary locating and supporting means for the water-chamber core and permitted the use of stud cores at *K* for clamping the water-chamber core down against its supporting cores. These stud cores also provided an outlet for any trapped gases.

PLASTER MOLDS FOR SMALL CASTINGS

By FRANK LUX

Plaster-of-paris molds have been in use for many years, but despite that fact, few people interested in the production of castings realize their value. They are especially useful as a means of producing small castings for experimental work, and in some cases they can also be used to advantage in the production of castings required in the construction of commercial products. A casting made in a plaster-of-paris mold is smoother than one made in a sand mold. This is quite an advantage when the appearance of the casting is important. For instance, if the levers, arms, brackets, etc., used in working models are cast in fine sand molds it is usually necessary to file the castings all over in order to obtain the desired finish, whereas if plaster-of-paris molds are used, a satisfactory surface is produced without filing.

Mixing Plaster for the Molds

Plaster-of-paris alone will not withstand the heat of molten metals, and experience has shown that the addition of asbestos is necessary to insure the success of so-called "plaster-of-paris" molds. Pure plaster would crack when heated, and the castings produced would not be uniform. The percentage of asbestos may be varied according to the material to be cast, although equal amounts of plaster-of-paris and asbestos generally produce very satisfactory results.

The mixing of the plaster is very simple, yet there are several points that require careful consideration. A pan or pail of suitable size is partly filled with water (the amount depending on the quantity of plaster required) and powdered plaster sifted into the water. When the sifted plaster thus piled up reaches the surface of the water, an equal amount of asbestos is added. Care should be taken not to stir the water and plaster-of-paris before adding the asbestos. After the addition of the asbestos the ingredients are stirred thoroughly. The asbestos is used in pulverized form.

Making the Molds

In making the mold, the pattern is placed on a piece of glass or smooth board and enclosed by a frame. If a frame is not obtainable, boards or strips can be used. At *A*, Fig. 1, is shown a frame of standard design. This frame rests on the glass *B*, although a slate-top table can be used if desired. The pattern *C* is located at the center of the frame, and the plaster is poured in until it has covered the pattern and fills the cavity in the frame.

In the lower view of the illustration, is shown a method of using four strips *D*, *E*, *F*, and *G* in place of frame *A*. The strips should be of sufficient height to allow the plaster to cover the pattern entirely, and they should be arranged to suit the size of casting to be made. A small amount of plaster should be poured on the pattern, and a soft brush used to brush the surface of the pattern over with the plaster before filling up the frame. This insures covering the entire surface and prevents the formation of air pockets.

Wooden and metal patterns should be covered with a coat of oil before pouring the plaster. This facilitates the removal of the pattern from the mold after the plaster has set. A mold of this kind will set in from twenty to thirty minutes. The frame is then removed and the top scraped to a flat surface. The plaster forming the drag, with the pattern still in position, is then turned over to permit casting the cope. The entire matching surface of the drag is covered with a solution of soapy water, which prevents the plaster forming the cope from adhering to that of the drag. Thus the two parts of the mold can be easily separated when the plaster has set.

Dowel-pins may be set into the drag before pouring the cope to insure alignment of the two members after the removal of the pattern. It is possible, however, merely to countersink the top surface of the drag, as shown at *A* in Fig. 2. Three or four countersunk depressions, such as

shown at A, are sufficient to insure proper alignment. When the cope is poured, the depressions in the drag form corresponding projections in the cope, thus providing a means of accurately matching these two members.

In making a mold for the knob shown at B, a somewhat different method is used. The knob is placed in a clearance hole D of a plaster slab C. Putty or wax E is then filled in around the knob, bringing the center up to the parting line. This allows half of the pattern to project above the surface. The plaster is then poured in the usual manner, after side frames or strips such as indicated at F have been suitably placed. In making the cope for this work, the plaster forming the drag is turned over after it has been separated from the plaster slab. The pattern or mold, in this case, is allowed to remain in the drag. The projecting part of the pattern is next coated with oil, and the parting surface of the plaster slab is coated with soapy water, as previously described. Dowels or countersunk holes are then provided to insure alignment, after which the plaster is poured to complete the cope.

When the mold has set, it is turned up on edge and the two parts are separated by inserting a knife blade in the parting line. Separation is not difficult if the knife blade is inserted in the parting line on all four sides of the mold. The general method of gating molds of this kind is to gouge out sufficient plaster to form the gate while the plaster is comparatively soft and moist. Standard gating methods should be used, since the metal flows the same in a mold of this kind as it does in the ordinary type. Gates can be built in the mold or patterns if desired.

Baking Plaster Molds

A plaster mold is somewhat moist for a considerable time after it has been made, and the best results are obtained by baking the mold in an oven, before using, for from twelve to twenty hours, according to the size, at a temperature of 650 degrees F. If no oven is available, the mold should stand for forty-eight hours in a dry place, after which it should be thoroughly dried and ready for use. After the mold has been baked or been thoroughly dried, it is clamped together with ordinary wooden clamps and placed on the floor or table so that the gate is at the top. The molten metal is then poured into the mold in the usual way.

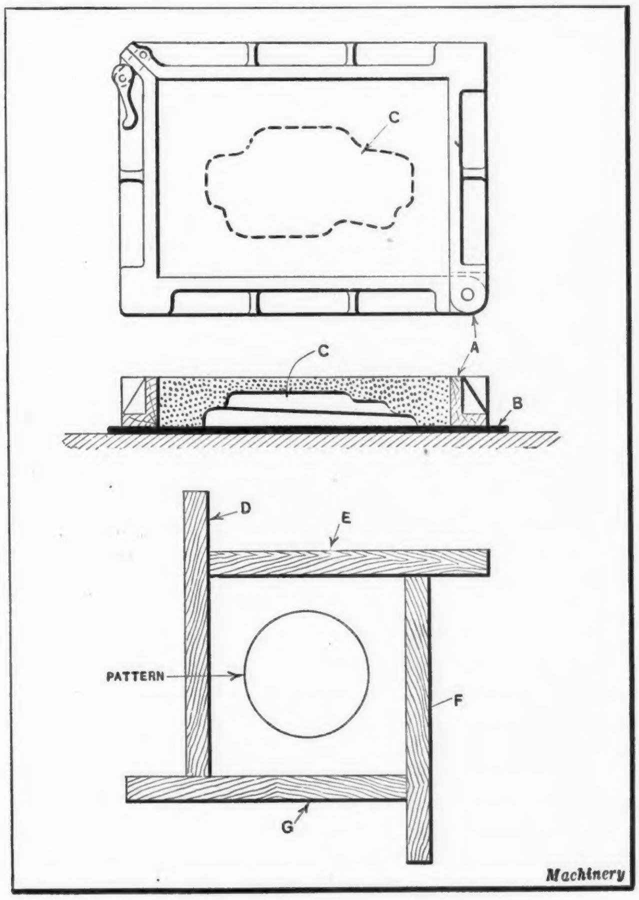


Fig. 1. Frames used in making Plaster-of-paris Molds

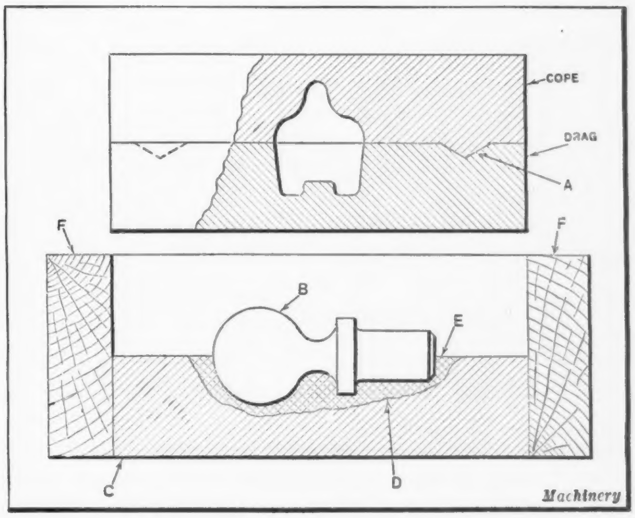


Fig. 2. Examples of Plaster Molding

Heating Furnaces

When the number of metal castings required is not sufficient to warrant the use of a large metal furnace, it is convenient to use an electrical furnace of the crucible type. The metal is brought to the proper heat, and then poured into the mold, where it is allowed to cool sufficiently to become set. The mold is then broken up and the casting removed and placed in a pickling solution. Some of the metals that can be molded satisfactorily in plaster molds are aluminum, and various grades of brass and cast iron. Stellite has also been cast successfully in plaster molds, and in some instances the results obtained have been better than with carbon or sand molds.

The following examples will serve to show some of the advantages of plaster molds: Assume that a connecting-rod, 5 inches long, of ordinary design is required to be cast in bronze. A wooden pattern could be used or the connecting-rod could be molded in wax, such as may be purchased in an art store. The wax mold can be worked out in a comparatively short time and is immediately ready for use. The surface is covered with oil, and the drag and cope are made as previously described.

Another example is the reproduction of a tablet bearing a face, figure, or some inscription. In this case the tablet is laid on a piece of glass and covered with oil, after which the plaster is poured. After setting, the plaster mold is turned over and the upper surface covered with a solution of soapy water. The dowels are next inserted, and the plaster backing is made. The two members forming the mold are then separated, gates cut, the pattern removed, and the mold dried or baked. By this method the original plate or pattern is reproduced in sharp detail.

Shrinkage Allowance

The allowance for shrinkage of castings made in plaster molds is the same as with other types of molds, and varies only according to the metal to be cast. Plaster generally keeps its size, although some plaster swells slightly. This swelling is governed by the proportions of the ingredients used. A foundry for producing castings from plaster molds does not require much equipment. Metal patterns can be used in making plaster molds, and production methods can be worked out with little difficulty.

There are many little kinks in the use of plaster molds that can be learned only through experience, but this article outlines general methods that will give successful results.

Cutting Internal Spur Gears

Milling Internal Gear Teeth with Formed Cutters—Generating the Teeth on Gear Shaper—Use of Form-copying Gear Planer

By FRANKLIN D. JONES

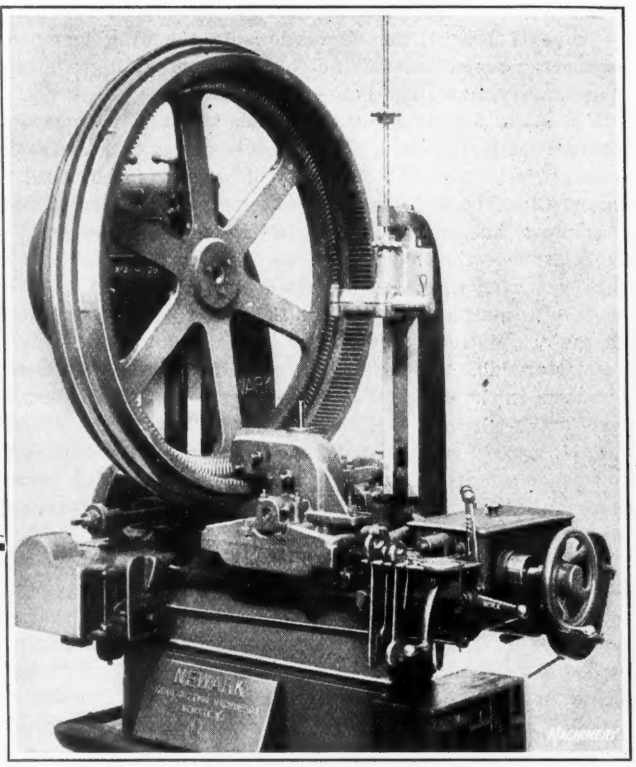


Fig. 1. Cutting an Internal Gear on a Machine equipped with an Internal Attachment

INTERNAL spur gears are cut by methods similar in principle to those employed for external spur gears, although the equipment used may vary somewhat owing to the fact that internal gears have teeth on the inside of a rim and frequently have a web at one side which limits the amount of clearance space at the ends of the teeth. Internal spur gears are usually cut by one of the following methods: (1) By using a formed cutter and milling the teeth; (2) by a molding-generating process, as when using a Fellows gear shaper; (3) by planing, using a machine of the templet or form-copying type (especially applicable to gears of large pitch); and (4) by using a formed tool which reproduces its shape and is given a planing action either on a slotting or a planing type of machine.

The machines used ordinarily for cutting internal gears are designs intended primarily for external gears. These machines are arranged for internal gear-cutting by using some form of attachment which provides means of holding the cutter in the position required for forming gear teeth around an inner surface. Attachments for cutting teeth by the milling process also transmit motion to the cutter.

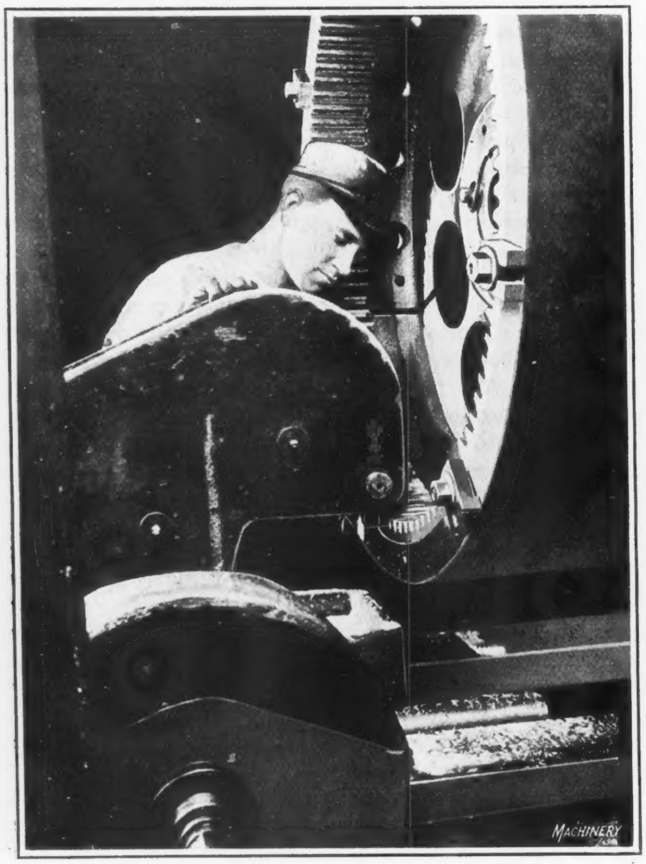


Fig. 2. Detail View of an Internal Gear-cutting Attachment at Work

Automatic gear-cutting machines of the formed-cutter type and designed primarily for spur gearing, are often used for cutting internal spur gears. The machine is adapted to this work by equipping it with a special attachment. Fig. 1 shows one of the Newark machines equipped with an internal attachment, cutting a large cast-iron internal ring gear. This attachment is mounted upon the regular cutter-slide of the machine, and the cutter is held at the end of a rigid arm which projects far enough to enable the cutter to operate on the teeth of an internal gear. The cutter is driven through a train of gearing from the regular cutter-spindle, the locations of the gear-shafts being clearly indicated in the illustration. The ring gear shown in this particular illustration is held in position by means of a cast-iron spider to which the gear is bolted, and the spider, in turn, is mounted on the regular work-spindle. These ring gears have 220 teeth of 5 diametral pitch, 2¾-inch face width, and a pitch diameter of 44 inches. Each tooth space was finished from the solid at one cut, using a feed of 5 inches per minute, and a cutter speed of 68 revolutions per minute. A high-speed steel cutter was used, and as twelve ring gears were required, a special cutter was made and ground to form after hardening.

In Fig. 2 is shown another example of internal gear-cutting. This is a close-up view of a machine made by the Cincinnati Gear Cutting Machine Co., equipped with an internal attachment for cutting steel internal gears having 96 teeth of 2 diametral pitch and a pitch diameter of 48 inches. These gears are also of the ring form, and are held in a special fixture mounted on the machine spindle.

When internal gears having webs are to be cut by means of rotary cutters, it is necessary to provide a clearance at the inner ends of the teeth which is somewhat greater than the radius of the cutter. As this amount of clearance may be objectionable, and as it may be very desirable to have the gear and web formed of one solid casting, the use of formed cutters and the internal gear-cutting attachment may not always be desirable or practicable.

Formed Cutters to Use for Internal Gears

When internal gears are cut by means of formed cutters, a special cutter is usually desirable, because the tooth spaces

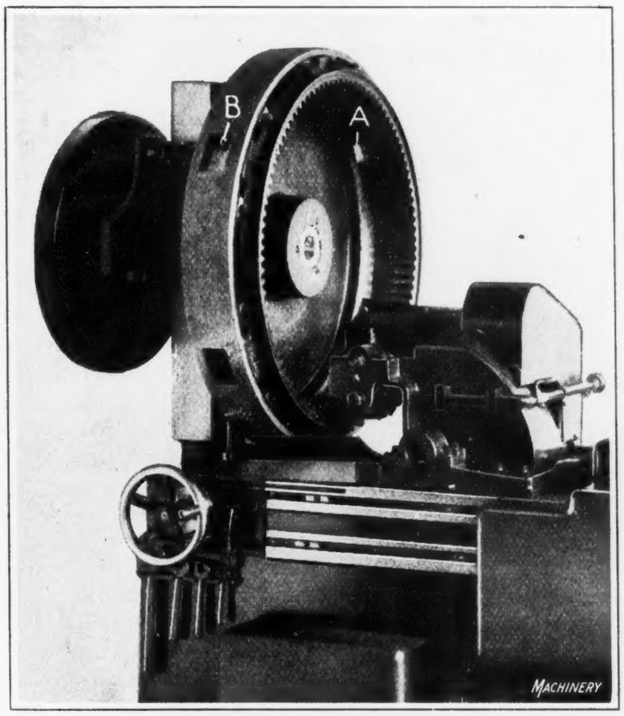


Fig. 3. Special Design of Internal Gear-cutting Attachment

of an internal gear are not the same shape as the tooth spaces of external gearing having the same pitch and number of teeth. This is due to the fact that an internal gear is a spur gear "turned inside out." According to one rule, the standard No. 1 cutter for external gearing may be used for internal gears of 4 diametral pitch and finer, when there are sixty teeth or more. This No. 1 cutter, as applied to external gearing, is intended for all gears having from 135 teeth to a rack. The finer the pitch and the larger the number of teeth, the better the results obtained with a No. 1 cutter.

According to the Brown & Sharpe Mfg. Co., if internal gears of high grade are required in quantity, it is preferable to have a special cutter made. The standard No. 1 cutter is considered satisfactory for jobbing work, and usually when the number of gears to be cut does not warrant obtaining a special cutter, although the use of the No. 1 cutter is not practicable when the number of teeth in the pinion is large in proportion to the number of teeth in the internal gear. If the difference between the number of teeth in the gear and in the pinion is less than 6, it is necessary to depart from the regular 14½-degree shape and use either a reduced depth or a greater pressure angle, or more often both. Ordinarily, the difference should not be less than 15 for the 14½-degree pressure angle. This number may be smaller for a larger pressure angle. According to the Newark Gear Cutting Machine Co., if a special formed cutter is not made to conform to the internal gear to be cut, it is considered preferable to use a straight-sided 29-degree worm milling cutter rather than a regular spur-gear cutter.

Special Attachment for Cutting Internal Gears

The special internal gear-cutting attachment shown in Figs. 3 and 4, applied to a Brown & Sharpe machine, was made for the purpose of cutting internal gears for tractors. This attachment, unlike the standard design, is driven from the cutter driving shaft by a silent chain and sprocket transmission, and it is not connected with the regular cutter-spindle. Fig. 4 shows the attachment with the guards removed. The special chuck or holding fixture receives two blanks at one time. These are held in place by hook-bolts. Recesses *A* and drain-holes *B* allow the cutting compound to escape from the fixture.

Double cutters are used, one for roughing and the other for finishing. The comparatively slow feed for the first cut is automatically increased for succeeding cuts. These cast-steel internal gears have 99 teeth of 3–4 pitch (stub teeth), and the total face width is 4¼ inches. The cutting speed is 74 revolutions per minute, with cutters 4¾ inches in diameter, and the feed is 1¾ inches per minute. The two gears are cut in 6¼ hours.

Cutting Internal Gears on a Gear Shaper

Internal spur gears are cut on a Fellows gear shaper by the same general process as that employed for cutting external spur gears. The same type of cutter is used, and the machine is geared so that cutter and work are rotated in unison like a pinion in mesh with an internal gear. An example of internal gear-cutting on a Fellows machine is illustrated in Fig. 5. Special cutters are not required for internal gearing, and frequently the cutter used for the mating gear or pinion is also used for cutting the internal gear.

The push or downward stroke is ordinarily used for cutting internal gears, instead of the pull or upward cutting stroke commonly employed for external gears. By using the push stroke, it is possible to cut internal gears having a web located very close to the ends of the teeth. In fact, if the groove is wide enough to prevent the chips from packing between the cutter and the work, that is the only requirement. In the case of internal spur gears, the minimum width of the recess or clearance space varies from 3/16 to 9/32 inch for gears ranging from 24 to 4 diametral pitch.

When setting up the machine, an intermediate gear is inserted in the train of change-gears, so that the cutter and work will rotate in the same direction when the machine is at work, instead of in opposite directions as is required when cutting a spur gear. In other words, the machine is geared to give the same relative motion between cutter and work as is obtained when a pinion is running in mesh with a gear, rotation of the pinion and gear being in the same direction for internal gearing and in opposite directions for external gearing.

The four standard sizes of gear shaper cutters having pitch diameters of 1, 2, 3, and 4 inches, respectively, meet all ordinary requirements in cutting internal gears. The size of cutter to use is governed by the number of teeth in the internal gear and the pitch. In the design of internal gear-

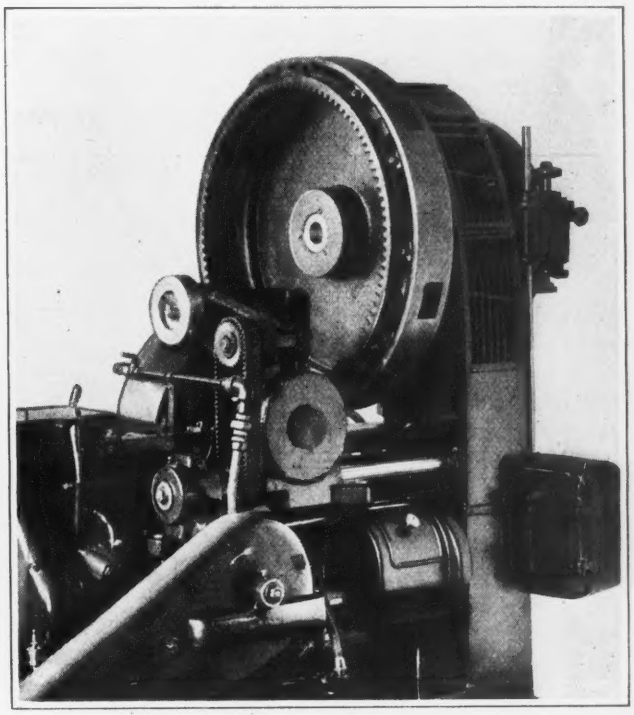


Fig. 4. Guards removed to show Chain Drive of Internal Attachment illustrated in Fig. 3

ing, if the pinion is made too large in proportion to the size of its mating gear, the teeth will not mesh properly because of interference. This also applies when selecting a cutter, since the latter represents a pinion and generates the tooth curves as the cutter and work rotate in unison at the proper ratio. If the difference between the number of teeth in the gear and the number of teeth in the cutter is too small, the cutter will trim off the tops of the teeth due to improper meshing, the result being teeth of incorrect shape.

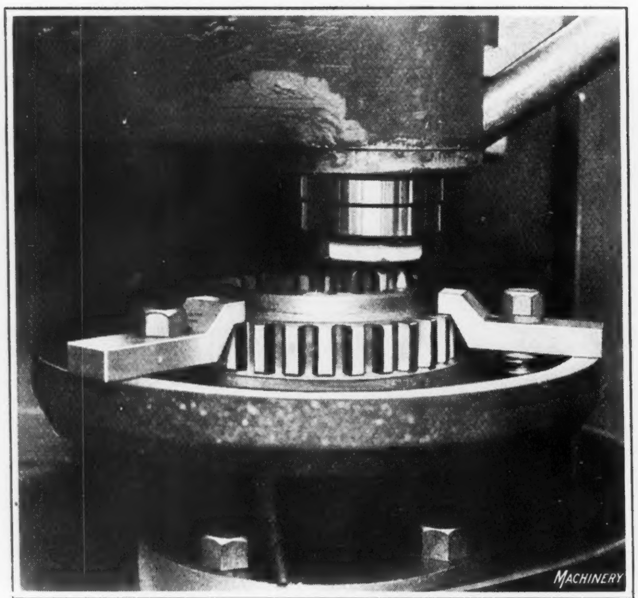


Fig. 5. Cutting an Internal Gear on a Gear Shaper

Internal gears are ordinarily held in special fixtures, the design of which depends on the shape of the gear and the number to be cut. For instance, a simple type of faceplate fixture may be employed when only a few gears are to be cut; whereas, for quantity production it would be economical to construct a special fixture, such, for example, as would enable the gear blanks to be accurately located with greater rapidity than when using a fixture designed for general work.

A typical design of internal fixture is shown in Fig. 6. It consists of a pan-shaped body having a machined seat *A* in which the gear blanks are held by clamping straps *B*. These straps have elongated bolt-holes, and are supported by springs so that they can be pushed back readily for inserting or removing work. The particular fixture shown is used for holding two ring-shaped gears *C*. The fixture is accurately centered in relation to the work-spindle by plug *D*, and it is supported on the cutting side by a roller at *E*.

Internal gears for speed-reducing mechanisms, etc., are often made with helical teeth in order to obtain a more perfect rolling action, and such gears may be cut on the helical type of gear shaper which will be referred to in a succeeding article.

Machine of Slotter Type for Cutting Internal Gears

A machine adapted for cutting internal spur gears, which is designed along the lines of a slotter, is shown in Fig. 7. This machine, which is of an automatic type, is used at the Bilgram Machine Works. When the machine is at work, the table is given an indexing movement, corresponding to the circular pitch of the gear, each time the tool clears the work on the upper stroke. The inward feeding movement occurs after each revolution of the gear blank. The indexing movement is derived through the change-gears *A*; just after this motion occurs, a cam-operated pawl or anchor engages a notched disk and holds the work-table securely during the downward or cutting stroke.

The feeding movement is obtained through a very ingenious pawl and ratchet mechanism. The ratchet wheel *B* has teeth formed along a spiral which makes several turns around the wheel as the illustration shows. Between the rows of teeth there is a narrow slot engaged by a projection extending below the hub of pawl *C*. This pawl is free to slide along rod *D*, and the projecting part causes the pawl to follow the spiral row of teeth as the ratchet wheel is rotated. As previously mentioned, this feeding mechanism operates after each complete revolution of the work-table, and it is so adjusted that when the tool has been fed to the proper depth the pawl slides out of engagement with the teeth on a blank space so that it cannot rotate the ratchet wheel further. The cutters used on this machine are of the formed type, the tooth curves being a direct reproduction of the cutter itself. The part shown on the machine is made of steel and contains sixty-seven teeth of 8 diametral pitch.

Cutting Large Internal Gears on a Templet-type Planer

The most practical method of cutting large internal gears is on a planer of the form-copying type. An example of internal gear planing on a Gleason machine is illustrated in Fig. 8. This is a regular spur gear planer equipped with a special tool-holder for locating the tool in the position required for cutting internal teeth. The holder is of a heavy, rigid design, which prevents excessive deflection of the tool.

The templets used to control the path followed by the tool conform to the shape required for internal teeth, and

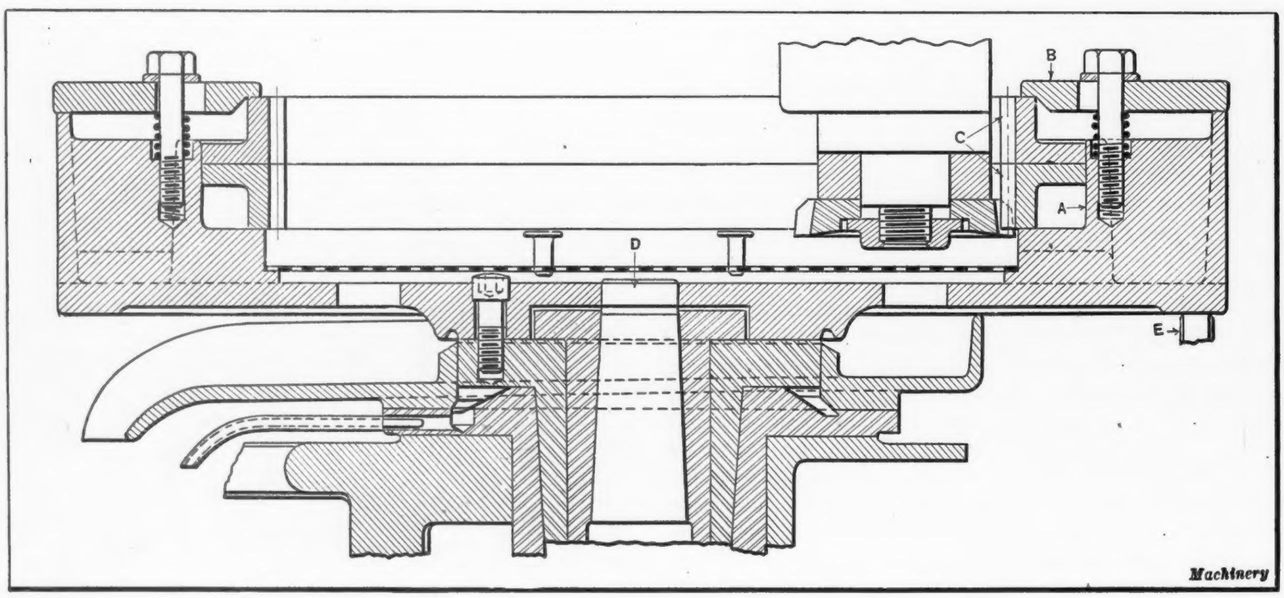


Fig. 6. Fixture for holding Internal Gears while cutting on a Gear Shaper

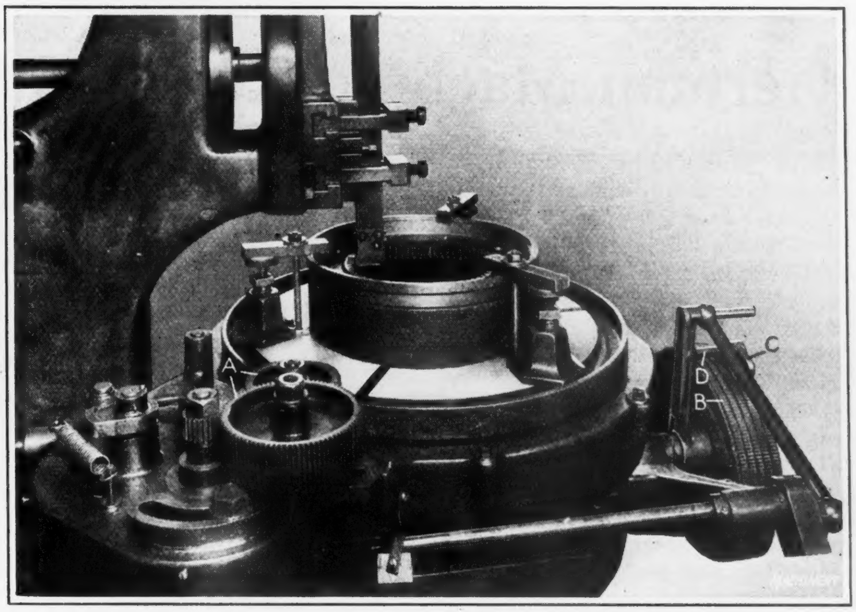


Fig. 7. Internal Gear-cutting Operation on Automatic Machine of Slotter Type

differ in shape from those used for external gears of the same size. Very satisfactory internal gearing may be cut on planers of this type, which are especially adapted for large work. The chief features governing the operation of gear planers of the templet type were described previously in connection with their application to large spur gears. The procedure of cutting internal gears is practically the same as for external spur gearing, after the machine has been equipped with the special tool-holder referred to.

Dimensions for Cutting Internal Spur Gears

As the position of the teeth of an internal gear are reversed as compared with an external gear, the addendum of an internal gear is inside the pitch circle and the dedendum outside; consequently, in machining blanks for internal gears the inside diameter is made equal to the pitch diameter *minus* twice the addendum. If the pitch diameter is not known, the inside diameter may be found by first dividing the number of teeth by the diametral pitch (thus obtaining the pitch diameter) and then subtracting twice the addendum. The addendum of an internal gear, the thickness of the tooth on the pitch circle, and the whole depth of the tooth may be obtained by the same rules or formulas as are used for external spur gears.

Internal gearing is frequently utilized in connection with various forms of speed-reducing mechanisms, since this type of gearing is often conducive to compactness in design. In fact, one advantage of internal gearing is that the center-to-center distance between gear and pinion is much shorter than between two external gears of the same ratio. If the diametral pitch and numbers of teeth in the gear and pinion are known, the center-to-center distance for internal gearing may be determined by subtracting the number of teeth in the pinion from the number of teeth in the gear, and dividing the remainder by twice the diametral pitch. Ordinarily, considerable reduction in speed is obtained through internal gearing, but occasionally gears of low ratio are required and then it may be advisable to use gear teeth of the cycloidal form. When using the involute form, the internal gear should have at least fifteen more teeth than its mating pinion in order to avoid excessive interference.

* * *

The Belgian automobile industry has been unable to supply the home demand since the Armistice, according to a Commerce Report, its total output being not more than 5000 cars a year. American cars are said to be more satisfactory as regards price and quality than the home products.

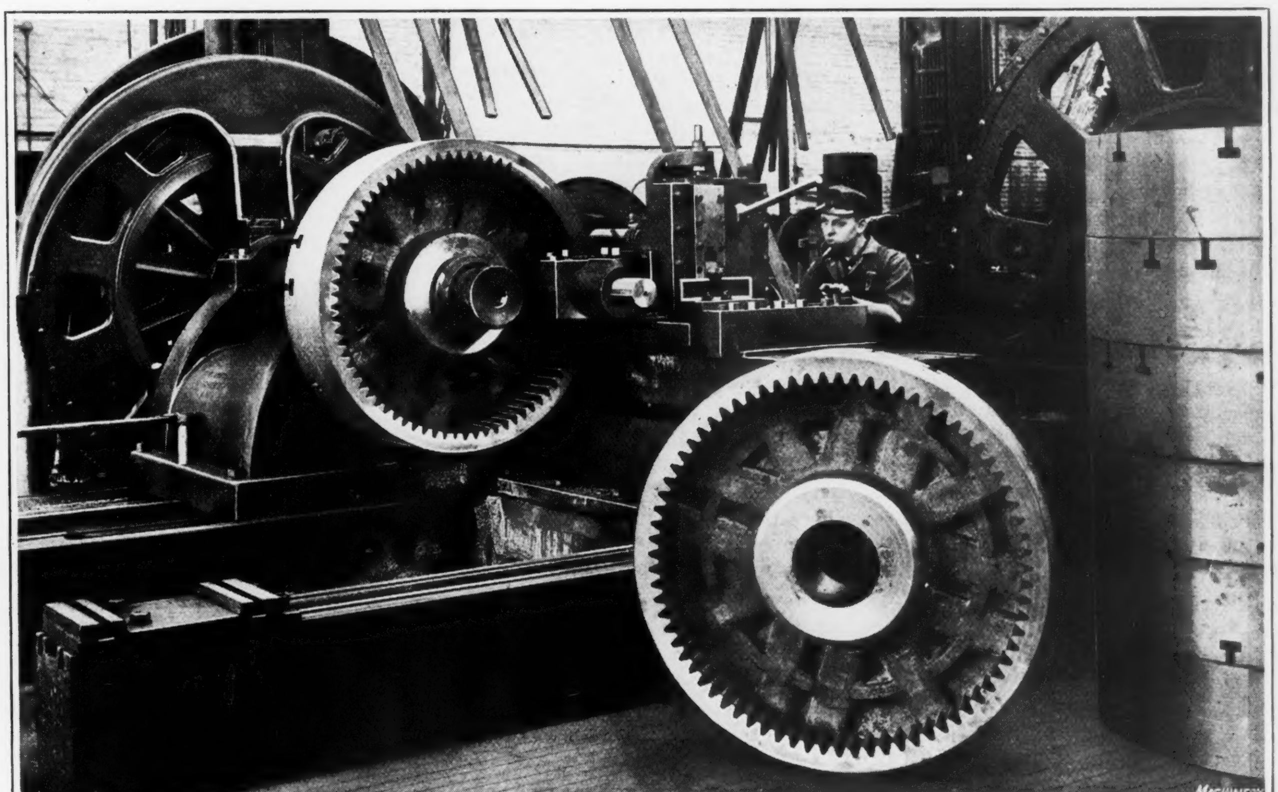


Fig. 8. Example of Internal Gear-cutting on Planer of Form-copying or Templet Type

The German Machine Tool Industry

Berlin, May 3

GERMAN industry in general, and the machinery and machine tool industry in particular presents to the casual observer a picture of activity and apparent prosperity. Were it not for the scarcity of raw materials and fuel, there would apparently be no cloud on the industrial horizon. In reality, however, conditions are not quite so satisfactory as they appear. The great industrial activity is due to the continuation of the selling-out process of Germany, which is accompanied by increases in prices to domestic consumers to such an extent that the great mass of the people in the country must deny themselves all those necessities that are on the price level of the world's markets. It is, therefore, not without fear and uncertainty that the captains of industry look into the future.

A foreboding of what might happen was presented by the strike of the railway employes early in the year. This strike was due to the extremely high prices of food, much of which has to be imported from abroad—and therefore must be sold at the world's market prices—as Germany cannot support its entire population with the agricultural products of its own soil. When imported products have to be bought with the depreciated German mark, prices compared with earning power rise to an almost unbelieveable level. While the skilled workman in Germany earns 10 marks an hour or 80 marks a day, a good suit of clothes costs as much as 6000 marks—in other words, it takes the entire earning power of a workman for seventy-five days to obtain a suit of clothes that at present exchange would be worth $20.

The railway strike lasted about six days, but no strike has ever so seriously threatened the economic existence of the country. Nearly everything came to a standstill, and in the six days the loss to the railroads was 1,800,000,000 marks, the value of destroyed materials 552,000,000 marks, and the estimated direct loss to the country 2,400,000,000 marks.

Results of the Leipzig Fair

More than 15,000 foreign buyers were attracted to the Leipzig Fair this spring, and on one day there were more than 140,000 visitors. The number of orders placed at the fair may be said to have been overwhelming. This applied to the machine tool industry as well, many orders being placed; but this must be considered as a selling-out fair for Germany, because if German money continues to depreciate, the manufacturers will be unable to replenish their stocks of such raw materials as have to be imported from abroad, and will not be in a position to continue production after present supplies are exhausted. Buyers conversant with the conditions in Germany know this, and if the difference between the German and the foreign price is not very large, they are reluctant to place orders in Germany, because they are uncertain as regards deliveries. There are examples on record of foreign makers underbidding German manufacturers by 30 per cent, especially in cases where the German manufacturer is forced to use imported raw materials.

Sliding Scale of Prices

In view of the uncertainty as to prices, orders for future deliveries are not taken at a fixed price, but in accordance with a sliding scale. Several methods are employed to determine this sliding scale. The Association of German Machine Tool Builders has formulated a rule intended to protect the interests both of the manufacturer and of the buyer. In accordance with this rule, current prices are quoted, but these prices are increased, if found necessary, by a certain percentage which is stipulated monthly by the association, the percentage of increase being added from month to month to the original price quoted.

Another rule that is followed on orders for certain classes of equipment is that the prices shall increase by 0.4 per cent for each per cent increase in the prices of raw materials during the first half of the period intervening between the placing of the order and the delivery; and by 0.4 per cent for each per cent of increase in average wages of skilled workmen during the second half of the time intervening between the placing of the order and the delivery.

Prices of Machine Tools in Germany

Expressed in marks, German machine tool prices are from forty to fifty times the prices previous to the war. At that time prices varied from 0.25 to 0.75 mark per pound, according to the size and type of the machine. At pre-war exchange, this meant a variation of from 6 to 18 cents a pound. At the present time the average price per pound of smaller machine tools is 25 marks per pound (from 8 to 9 cents per pound); on larger machine tools the price is approximately half of this, or about 5 cents per pound. A number of examples of present prices are given below:

24-inch lathe, 10-foot bed, weighing 13,200 pounds, 130,000 marks (present exchange, $435).

18-inch engine lathe, 3½ feet extreme distance between centers, weighing 3200 pounds, 48,000 marks (present exchange, $160).

16-inch relieving lathe, 3½ feet between centers, weighing 4200 pounds, 100,000 marks (present exchange, $335).

Vertical milling machine with rotary table, weighing 6500 pounds, 150,000 marks (present exchange, $500).

Centering machine for pieces up to 6 inches in diameter, weighing 700 pounds, 20,000 marks (present exchange, $67).

High-speed drilling machine with capacity for drills up to one inch in diameter, automatic feed, weighing 660 pounds, 15,500 marks (present exchange, $52).

Drilling machine, with capacity for drills up to 1⅝ inches in diameter, weighing 1200 pounds, 20,000 marks (present exchange, $67).

Small vertical boring and turning mill (20-inch capacity) weighing 3300 pounds, 100,000 marks (present exchange, $335).

Horizontal milling machine with single-pulley drive, weighing 10,000 pounds, 200,000 marks (present exchange, $670).

Planer, 40 inches between housings, extreme height of work, 32 inches, weight, 12,000 pounds, 180,000 marks (present exchange, $600).

Planer, 60 inches between housings, extreme height of work, 52 inches, length of table, 13½ feet, weight, 35,000 pounds, 430,000 marks (present exchange, $1435).

Tool grinding machine with 20-inch wheel, weight 1000 pounds, 19,000 marks (present exchange, $64).

Shaper, 26 inches travel of ram, weight 4500 pounds, 105,000 marks (present exchange, $350).

Punch press for holes up to 1⅜ inches in diameter and 13/16 inch thickness of plate, weighing 34,500 pounds, 360,000 marks (present exchange, $1200).

Cold saw, 40-inch diameter of saw, weighing 13,600 pounds, 180,000 marks (present exchange, $600).

Plate-bending machine for plates ½ inch thick and up to 6½ feet wide, weighing 9000 pounds, 150,000 marks (present exchange, $500).

General Conditions in the Machine Tool Industry

As already mentioned, business is at a high peak. The shops are overcrowded with orders, and the demand con-

tinues to be very brisk. Ludwig Loewe & Co. of Berlin, for example, now employ 3200 men in their shops, and the office employes number 620. It is stated, however, that this firm, like all other machine tool plants, finds it difficult to obtain the necessary raw material and coal.

The wages in the industries are approximately 10 marks per hour (4 cents per hour, present exchange) for skilled workers over twenty-four years of age. The wages for unskilled workers are only 5 per cent less than the wages of skilled men. Women engaged in shop work are paid about 6 marks per hour (2 cents per hour, present exchange). When working on piece-work, all workers earn at least 15 per cent over the hourly wage. For certain skilled work, the wages may be 10 per cent above those mentioned. The working day is eight hours for six days, or a forty-eight hour week. Six to nine days vacation is allowed annually with pay. Men in the engineering departments, capable of independent designing work, are paid from 3500 to 4400 marks a month (present exchange, from $12 to $15), while assistants, draftsmen, etc., earn from 1300 to 1900 marks a month (present exchange, $4.35 to $6.35).

General Industrial Conditions

General industrial conditions are paradoxical. The depreciated value of the mark has created an apparently large export trade with plenty of employment, yet the great masses of the people suffer want and the middle class is brought to the verge of actual poverty. Combinations in the industries are the order of the day, both in the machine tool building industry and in the general machine building field. The aim of these combinations is to lessen competition and reduce production and selling costs. These combinations include not only firms engaged in a similar line of manufacture, but also businesses that are using the raw materials of some other industry. As an example may be cited a combination including one of the largest locomotive builders in Germany, one of the steel mills, and one of the coal mining companies, so that the control of the production from the raw material to the finished product is in the same hands.

In 1921 Germany was still holding second place as a producer of iron and steel—the United States being the leader in this respect, France coming third, and Great Britain, fourth. In 1921 Germany bought 40 per cent of the copper exported from the United States, as compared with 33 per cent previous to the war. Iron ore being scarce in Germany, contracts have been placed for ore in Canada. During the past year exports have increased, but unless raw materials can be obtained from abroad at reasonable prices, Germany cannot continue indefinitely to export, as it is necessary that she first import many of the raw materials which are not found in sufficient quantity, or at all, in Germany. As an example of present methods of trading, it may be mentioned that the Krupp firm of Essen has obtained from Argentina an order for rails, part of which will be paid for by shipments of wool.

The Soviet Government has placed orders for 1000 locomotives in Germany, 85 of which have already been delivered. An order for 1000 locomotives has also been placed by the Soviet Government in Sweden, and the requirements are that all the parts of the locomotives built in Germany and in Sweden must be interchangeable with each other.

Negotiations have been completed between the Siemens-Schuckert Works and large Japanese copper interests, and an agreement has been made to erect a large factory in Tokio for the building of electrical machinery. Twenty of the leading engineers of the Siemens Works, as well as other technical employes and foremen, are just leaving for Tokio. The machinery for the starting of the works will also be supplied by the Siemens-Schuckert Works.

Orders for rails have also been placed in Germany by Brazil, the German bid being 3 per cent lower than that of Belgian makers. An order for a large iron bridge in Argentina has also been obtained by a German concern.

SAVINGS IN THE FOUNDRY

The practice of molding the cylinder casting for a pitcher pump as followed in the foundry of the Goulds Mfg. Co., Seneca Falls, N. Y., shows how money can be saved by giving attention to foundry details. The casting, which is illustrated in Fig. 1, was formerly molded with a green sand core that was rammed up in a core-box and then immediately put in position in the mold. Much difficulty was experienced by this procedure, and it was necessary to have considerable extra work done by an experienced core-maker. A core-box split through the spout was employed, and this core was rammed by hand first from one end and then from the other. When removed from the core-box and placed in position in the mold, it was necessary to be exceptionally careful in handling, and much loss of effort resulted through the disintegration of the core and the overhanging sand in the spouts falling off.

These castings are still molded with a green sand core, but other means of ramming the core are employed. A Mumford jolting machine is used on which a cast-iron box is attached, as illustrated in Figs. 2 and 3. In Fig. 2 the box

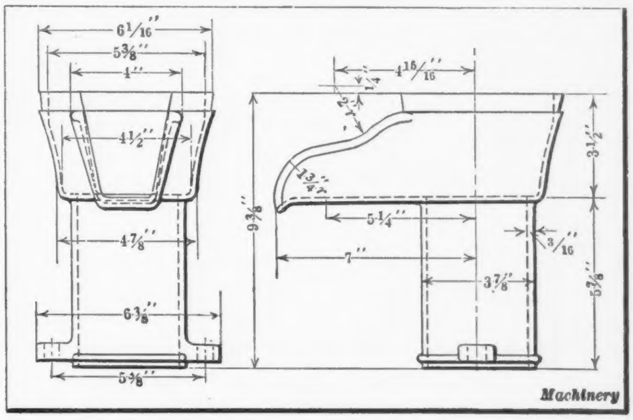


Fig. 1. Pitcher Pump Cylinder Casting

is shown closed and clamped, and the sand is jolted around a central arbor *A* which has ribs for supporting the sand and a square socket at the bottom to locate it in the cast-iron core-box. After the sand has been air-jolted, the top is swept off and the box opened as shown in Fig. 3. There is a pin in the upper end of the central arbor for lifting the core conveniently from the box. After the core has been removed from the box, it is dried in the air, the socket at the lower end of the arbor fitting over a pin to support the core while drying. In jolting this core, the arbors are wet with a clay wash so that the sand will hold, and the sand itself is, of course, dampened. Provision is made for jolting large quantities of these cores at a time and for standing them on pins where they can dry thoroughly and evenly.

Before this arrangement was adopted, blow-holes were produced in the casting by the sand not being evenly or thoroughly dry at the time that the molten iron came into contact with the core. The core-box is rigidly supported at the bottom and at the spout end, and the front cover is located by dowel-pins and can be quickly removed. These facilities make it possible for a boy to make 350 cores a day. This represents a considerable saving as compared with the former practice, which required an experienced molder and core-maker. The use of the jolting machine not only effected a saving in time of more than 50 per cent, but also produced more satisfactory cores than could be made with a hand-rammed core-box, and eliminated the expense of an experienced core-maker.

Economies in Molding Air Chambers

The Goulds piston pump is equipped with an air chamber of the style illustrated by full lines in Fig. 4. The dry sand core for producing the interior of this air chamber at one time was made in a core-box which left a hole in the curved

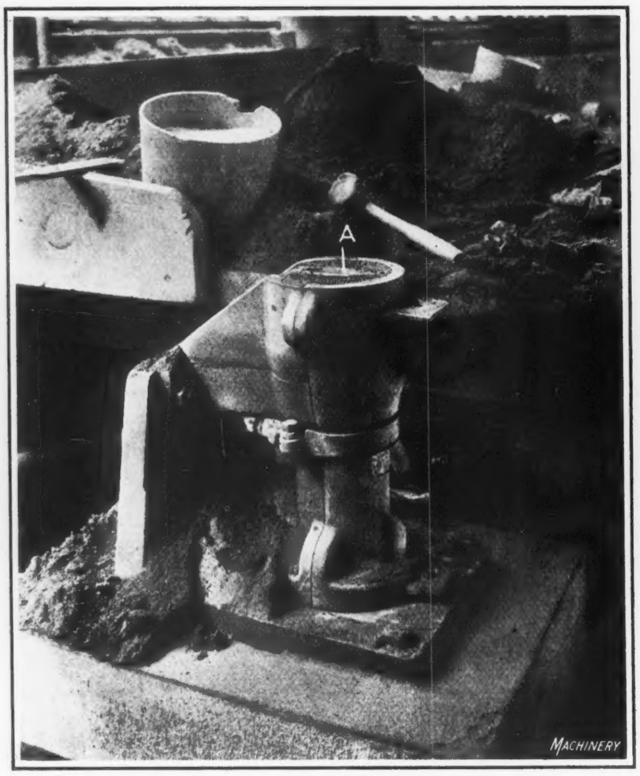


Fig. 2. Jolting Machine with Cast-iron Core-box in which the Core is jolted

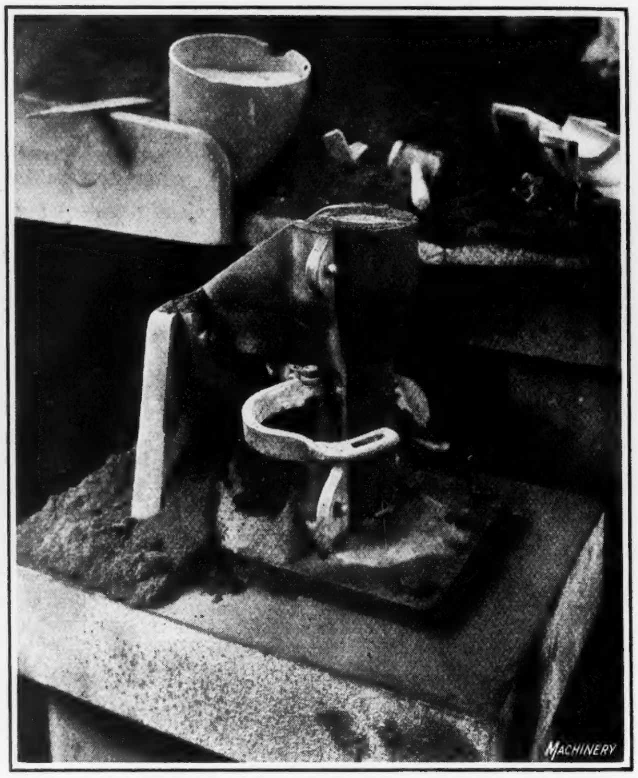


Fig. 3. Jolting Machine shown in Fig. 2, with Front Cover of Core-box removed

end at *A* so that the casting had to be machined at this end and the hole closed with a ¾-inch gas pipe plug. It was realized that something should be done to reduce this expensive procedure and eliminate, if possible, the necessity for plugging a hole in the casting. This was accomplished by the use of a balanced core, shaped at each end as indicated by the broken line, with a balancing connection of sand at the center so that two cores held together by this body of sand could be placed in the mold and supported without the use of chaplets or any other means. In addition, two sound castings were obtained from each mold so that the subsequent machining operations were entirely dispensed with and double the number of castings were produced in the same time.

* * *

CUTTING THERMIT WELDING COSTS

Investigations recently conducted by the research department of the Metal & Thermit Corporation indicate that the amount of thermit used in making welds is generally needlessly large, and that a saving can be effected by reducing the size of collars or reinforcements, width of gaps, and dimensions of gates and risers. It is claimed that the saving in thermit thus obtained reduces the cost of welding large members or sections at least 10 per cent, and in the case of small sections the saving is much greater.

As an example it was found that a 2- by 4-inch section for which 40 pounds of "railroad thermit" was formerly recommended, could be welded with only 10 pounds of thermit under the new specifications. On the average locomotive frame section a saving of over 10 per cent is generally effected. The use of pneumatic rammers, smaller mold boxes and various labor-saving devices introduced in the past year are also cost-reducing factors.

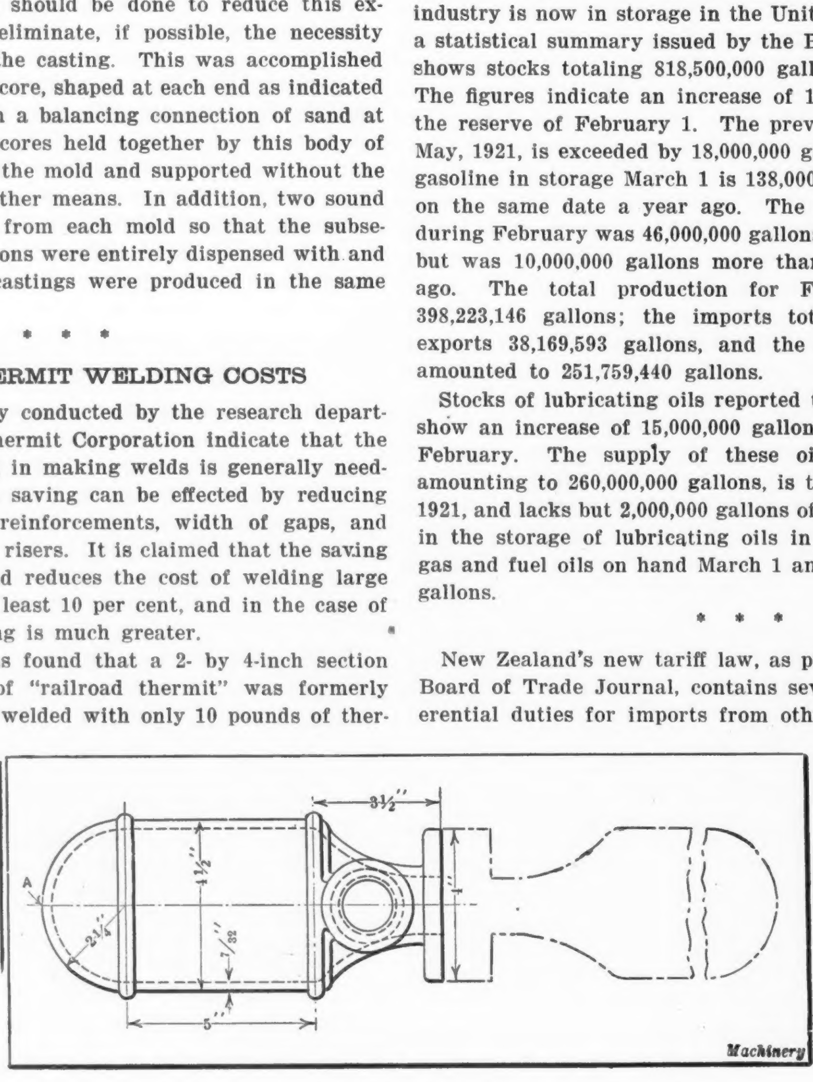


Fig. 4. Piston Pump Air Chamber and Core used in molding the Casting

RESERVE SUPPLIES OF GASOLINE

The greatest reserve of gasoline in the history of the industry is now in storage in the United States, according to a statistical summary issued by the Bureau of Mines, which shows stocks totaling 818,500,000 gallons on hand March 1. The figures indicate an increase of 112,800,000 gallons over the reserve of February 1. The previous high figure set in May, 1921, is exceeded by 18,000,000 gallons. The amount of gasoline in storage March 1 is 138,000,000 gallons more than on the same date a year ago. The production of gasoline during February was 46,000,000 gallons less than for January, but was 10,000,000 gallons more than for February a year ago. The total production for February amounted to 398,223,146 gallons; the imports totaled 4,979,625 gallons, exports 38,169,593 gallons, and the domestic consumption amounted to 251,759,440 gallons.

Stocks of lubricating oils reported to the Bureau of Mines show an increase of 15,000,000 gallons during the month of February. The supply of these oils on hand March 1, amounting to 260,000,000 gallons, is the greatest since June, 1921, and lacks but 2,000,000 gallons of the high point reached in the storage of lubricating oils in May, 1921. Stocks of gas and fuel oils on hand March 1 amounted to 1,314,740,284 gallons.

* * *

New Zealand's new tariff law, as published by the British Board of Trade Journal, contains several evidences of preferential duties for imports from other parts of the British Empire. Machinery and metal products are either free or assessed at various duties up to 20 per cent if from other parts of the Empire, but are subject to from 10 to 35 per cent duty if from other parts of the world. For the most part the duties are ad valorem.

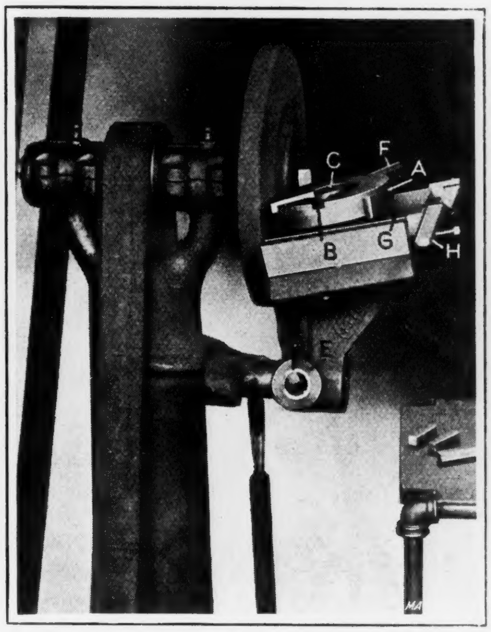


Fig. 12. Disk Grinder with Swiveling Attachment for grinding End of Chasers

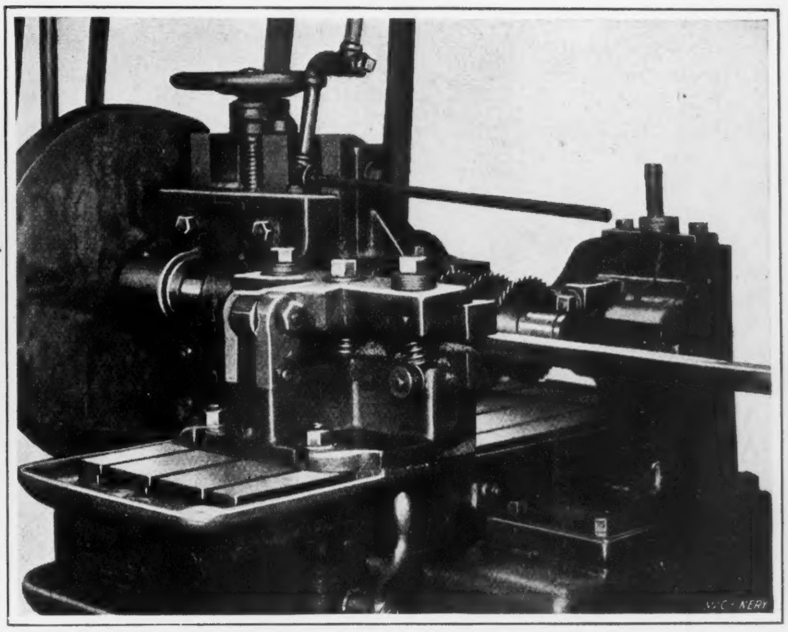


Fig. 13. Cutting Bar Stock into Blanks on a Milling Machine equipped with Multiple Saws and a Holding Fixture

Pipe Threading Tools and their Manufacture

Methods Used in Making Die-stocks and Chasers—Second of Two Articles

THE first article on pipe threading tools and their manufacture, published in May MACHINERY, contained a description of several machining operations required in the manufacture of Beaver die-stocks, as well as a detailed description of a special machine for milling the pin slots in the chaser cam-plates. The present article describes the methods employed in manufacturing the thread chasers, including the heat-treatment and inspection. The methods used for determining the pull required in threading pipe, expressed in pounds, is also included.

Making the Chasers

The steel used in manufacturing the chasers is a hot-rolled high-carbon tool steel. It is claimed that hot-rolled steel gives better results than cold-rolled steel, because the desired accuracy of the chaser can be more easily maintained with the hot-rolled product. The bars are cut off on a Becker milling machine of the Lincoln type, on the arbor of which a gang of cutting-off saws is carried. The set-up is illustrated in Fig. 13, which shows the stock held in a special fixture. The jaws of this fixture are spring-actuated, which permits the stock to be readily freed after the blanks have been cut off and it is desired to advance the bar into the jaws preparatory to cutting off another series of blanks. After the blanks are cut off, they are ground on a Blanchard or a Pratt & Whitney grinder and the pin-holes drilled in which the pins that engage the cam-plates are assembled.

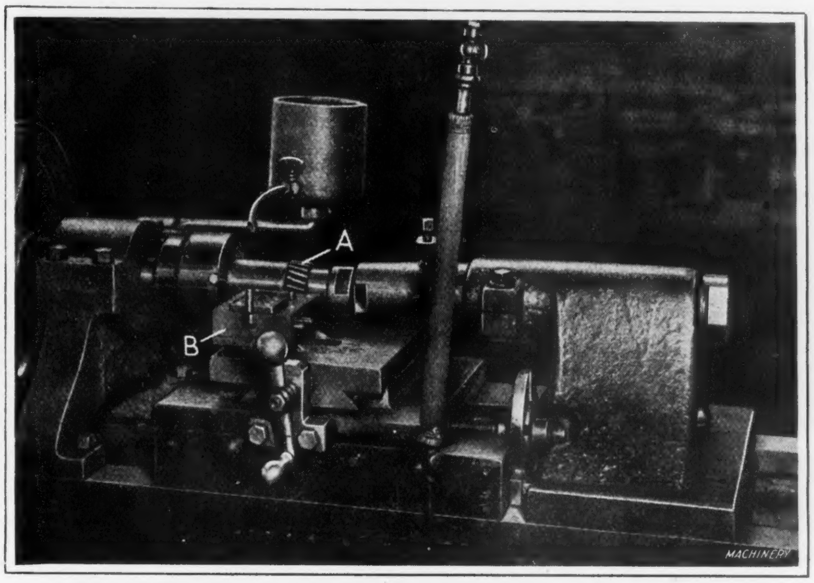


Fig. 14 Equipment used in milling the End Surfaces of the Chasers in which the Threads are subsequently cut

The next operation is that of milling a curved surface on the end of the die blanks. This surface, besides being curved, is in an angular plane, so that a taper cutter mounted in the horizontal plane of the center of the chaser is required. In Fig. 14 is shown a special milling machine equipped with a tapered cutter *A* such as just referred to. The blank is held in a slot in tool-block *B*, and is located by means of the previously assembled cam-plate pin. There is nothing novel about the design of this machine, but the outstanding feature in its construction is its rigidity. The carriage is heavy and the tailstock substantially braced. The milled surfaces produced on this machine are those in which the threads are subsequently milled.

For the thread-milling operation a special machine of the type illustrated in Fig. 15 is employed. The blank *A* is clamped to the fixture *B*, and is positioned by the pin in the work, and stop *C*. In connection with this operation, it should be borne in mind that the lead of the threads in each chaser of a set is advanced one-fourth of a turn, so that all chasers for the first position are milled at one setting of the machine. When the second lot of chasers is to be milled, it is simply necessary to advance the position of the lead-screw nut *E* a distance equal to one-fourth the pitch of the thread (provided that four chasers constitute a set), throw the nut into mesh with feed-screw *F* by means of handle *G*, and proceed as before. There is a micrometer adjustment, the knurled adjusting screw of which is shown

at D, for setting the lead-screw nut accurately when another chaser in a set is to be milled. The third and fourth sets will be milled after advancing the lead-screw nut a like amount.

There are two operations of great importance, as regards the operation of the die-stock, which follow the thread-milling operation. These are the grinding away of the thin fin where the thread starts, and the grinding of what is termed the "lead," which is a bell-mouthed enlargement of the chaser opening to facilitate the start in cutting the thread.

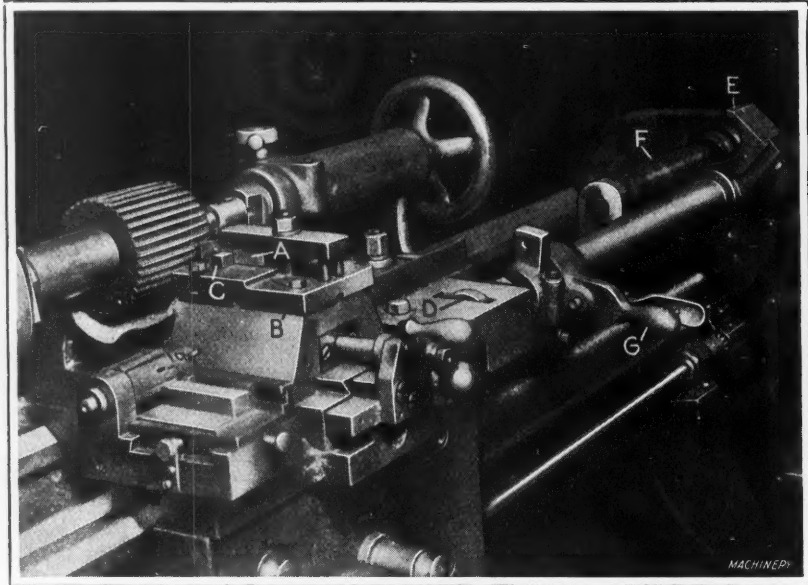


Fig. 15. Milling the Threads in the End of Chaser Blanks, using Special Machine and Tapered Milling Cutter

Chasers used on die-stocks of the type shown in Fig. 3, of the first installment of this article have an angular surface at the rear which has a cam action in relation to the inner wall of the outer housing. This angular surface is ground on the grinding machine shown in Fig. 12, to which there is attached an auxiliary rest, tilted at an angle, on which a swiveling block A is attached. This swiveling block has two radial slots B and a circular clearance space around the center post C, on which washers of various thicknesses may be placed so that chasers of various lengths may be ground. Two of these washers are shown at D and E hanging on a set-screw.

The swiveling block is swung back and forth, passing the end of the chasers over the grinding wheel, by means of the lever F. The angle at which the swiveling block is mounted corresponds, of course, with the angle required at the end of the chasers. The carriage G rides in parallel ways in the cast-iron base, and is operated against spring tension by handle H, when carriage adjustments are required. Before being sent to the hardening room, the chasers are marked to show their relative position in the die-head.

Heat-treating and Inspection

The dies are heated in molten lead, first being preheated to a temperature of between 1000 and 1100 degrees F., and later to a final hardening temperature of 1550 to 1600 degrees, depending on the grade of steel used. The quenching medium is salt water, which is agitated by a circulating pump. After hardening, the parts are drawn in oil at 350 to 400 degrees F. Two hardness tests are employed; first the hardness is tested by a file, and then it is checked by the scleroscope, the required reading being between 65 and 75. Finally, the chasers are ground on the side to gage limits on a disk grinder and sharpened.

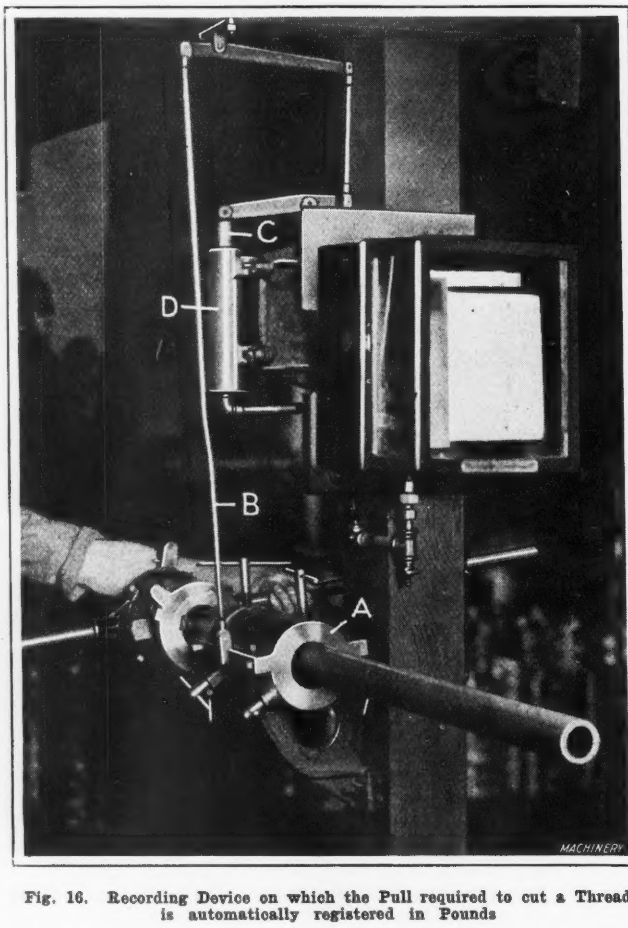


Fig. 16. Recording Device on which the Pull required to cut a Thread is automatically registered in Pounds

There are a number of interesting gages used in the inspection of the chasers, three of which are illustrated in Fig. 18. The gage shown at A is used for inspecting the chasers for the small dies, both for length and for lead and location of the thread. There is a set of master blocks D provided with the gage for the purpose of setting the center indicator E at zero prior to the inspection of a lot of chasers. The adjustment is accomplished by means of the knurled screw G. After adjusting the indicator with handle M, it may be swung down against the chaser F to determine the length.

The chaser is located by stop-pin H against block I, the threads of the chaser engaging with threads in the master mating members. There are four of these masters, one at each station, as may be clearly seen at J. This gage may be used to check the elements of all the chasers in a set of four by indexing the turret K, which may be locked by key L. If the chaser does not properly engage the master on the turret, it is too long, and this will be indicated on the graduated scale of the center indicator.

The gage shown at B in this illustration is used for checking the over-all length and the pitch of threads on the larger sized chasers. The chasers are located by the cam-pin against block N, in which position they are inspected by means of the two micrometer heads with which the gage is provided. The anvil O of one of these heads has a conical point to correspond with the angle of thread, in which it engages for checking the length. The other micrometer spindle is then used to check the distance from the thread in which the pointed anvil is engaged to the side of the gage against which the chaser rests. This checks the proper location of the threads.

The gage shown at C consists of a block carrying a master gage P which has the appearance of a pipe tap. By turning this master gage so that the chasers of a set may be successively inspected, and by the use of a dial gage, the length and thread may be quickly tested. The chaser is

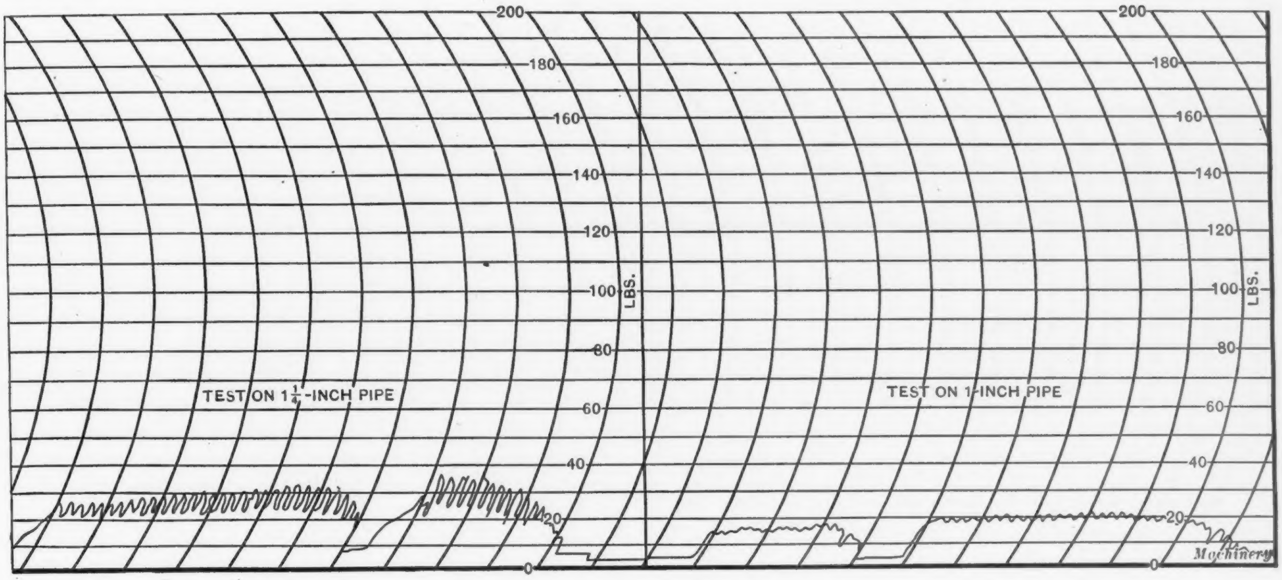


Fig. 17. Reproduction of a Section of the Recorder Tape on which the Amount of Pull in Pounds is registered

located in the gage against a block, and is held in contact with the master gage by a spring block Q, which may be withdrawn from contact with the end of the chaser by means of knob R. A flat spring S exerts tension against the side of the chaser and serves to hold it in the proper position for gaging.

After the work has been placed in the position described, the operator permits the spring block Q to bear against the end of the chaser, noting at the same time the reading of the dial indicator. This shows him, at a glance, the deviation, if any, that exists in the length; the engagement of the threads of the chaser with the master gage may also be readily observed. The spring block carries a pin T on the side which is held in contact with another pin U, driven into the small cross-shaft V, by a light coil spring. As the cross-shaft V is rocked when the spring block is moved in and out, a finger on the opposite side of the shaft extends under the vertical plunger W of the dial indicator and operates the indicator needle. In setting this master gage, it is necessary, of course, to obtain a zero reading on the dial, and this is done by regulating the adjusting screw X at the rear of the gage.

Recording the Pull Required to Cut a Pipe Thread

The method of testing the pull required to cut a thread with die-stocks of various sizes is of considerable interest. The apparatus used is illustrated in Fig. 16 and consists, briefly, of a Bristol recording instrument, which is operated by hydraulic pressure through the medium of a series of levers, so that the exact amount of exertion required to thread a pipe is graphically recorded on a chart. As the die-stock is turned, the vise A in which the pipe is held, can swivel slightly, due to the force exerted by the operator, with the result that the connecting-rod B and a series of levers operate the plunger C in the oil cylinder D, producing an amount of pressure which shows the exertion required to cut a thread. The number of pounds pull required is recorded on the chart.

The tape in the recorder travels at the rate of 6 inches per minute, so that in addition to the pull required, it is possible to determine very closely the amount of time consumed in the operation. A section of one of these recorder tapes is reproduced in Fig. 17, showing the results of tests made on pipe of 1 inch and 1¼ inches diameter, respectively. In the first instance a pull of 20 pounds was exerted during the first part of the work. It will be noticed that the traced line then drops abruptly down, during which period the operator was probably engaged in oiling the chasers. At the resumption of the pull after oiling, the pressure is shown to be about 3 pounds less than before oiling. Referring to the other test, it will be noticed that the maximum pull was 38 pounds before oiling; the recording needle dropped down during the oiling operation, and afterward a maximum pull of 34 pounds was exerted.

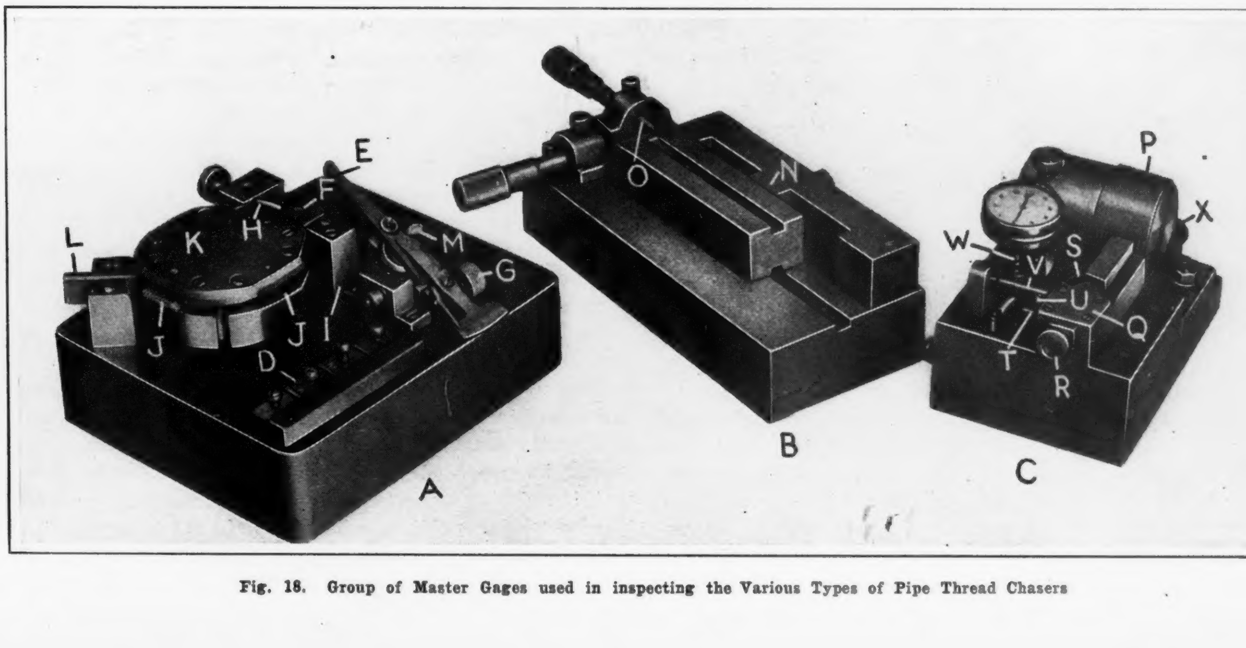


Fig. 18. Group of Master Gages used in inspecting the Various Types of Pipe Thread Chasers

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MACHINE TOOL STANDARDIZATION

The important decision reached at the last meeting of the National Machine Tool Builders' Association, to undertake extensive standardization work, will be welcomed by the entire metal-working industry. Lack of standardization, which prevents using cutting tools, fixtures, and accessories interchangeably on different makes of machine tools, has added greatly to manufacturing costs by increasing the amount of tool equipment required. The cooperation now existing between the National Machine Tool Builders' Association and the American Society of Mechanical Engineers, fostered by the American Engineering Standards Committee, will undoubtedly result in noteworthy economies, both to builders and users of machine tools.

In his address before the National Machine Tool Builders' convention, A. H. Tuechter, the president, emphasized the needs for standardization, and referred to the growing demand for it from users of machine tools. Mr. Tuechter mentioned one case where the standardization of the dimensions of one hole enabled the manufacturer to utilize more than $5000 worth of tool equipment which he was using on another machine. Mr. Tuechter also referred to the standardization of milling machine spindles by the Associated British Machine Tool Makers, which will enable the interchangeable use of milling cutters and arbors.

In connection with this new departure by the National Machine Tool Builders' Association, it is not intended to standardize the individual features of machines which may be considered superior to those of competing tools—driving and feeding mechanisms, for example, may be of different designs without being subject to standardization. It is to the advantage of the user that improvements are continually being made in such features. Standardization is required principally in the work-holding and tool-holding parts or appliances of machines, and this important feature of the work should be undertaken first. Should it be found desirable later to standardize other features, this can be done step by step, in accordance with the judgment and experience of the manufacturers themselves. The buyer is interested principally in the interchangeability of tooling equipment between machines of different makes, and he is justified in asking for the standardization that directly affects this.

* * *

UNIFORM APPRENTICESHIP SYSTEMS

The need for a uniform apprenticeship system in the metal-working industries is generally recognized and a most promising step toward meeting it has been taken by the National Metal Trades Association in endorsing the report presented at the annual meeting by Harold C. Smith, president of the Illinois Tool Works of Chicago, who is chairman of the Industrial Training Committee of the association. His report provides for an apprenticeship system in which is embodied many good features of several systems that have been in use in American shops, and also includes a number of suggestions relating to new and improved features. A thorough examination of apprenticeship systems now used in various shops and in communities where manufacturers cooperate in the training of young shop men, was made by the committee. The report frames courses of shop training, suggests a standard diploma for apprentices in the metal-working industries, and provides for an exchange of apprentices among shops which are too small to furnish alone thorough and all-around training.

The committee dealing with the problem is one that commands the respect of the entire metal-working industry, the members, besides Mr. Smith, being John C. Spence, works manager of the Grinding Machine Division of the Norton Co., Worcester, Mass., and William Taylor of the Chandler & Taylor Co., Indianapolis, Ind. Manufacturers everywhere are strongly urged to investigate thoroughly the proposed apprenticeship system, and to arrange for putting it into effect in their own plants.

Where shops are too small to maintain individually the kind of apprenticeship system proposed, some active manufacturer should begin immediately to cooperate with his neighbors and start a group movement in his community. If shops are running at greatly reduced capacity it may not be possible to begin actual operation immediately; but plans can be formulated now, while there is ample time for that part of the work, and carried out when business is more active. The future of the American machine-building industries undoubtedly depends upon a constantly increasing supply of highly skilled all-around mechanics.

* * *

SHOP PRACTICE AND DESIGN

A designing engineer said recently that the present tendency in technical book publishing was to bring out a great many books on shop practice but very few on subjects pertaining specifically to machine design. He felt that the needs of the designer were being overlooked; but in this assumption he was in error.

During the early period of technical book publishing, the larger number of volumes related to machine design—the theoretical or preliminary part of the work necessary to produce a machine or mechanism. In recent years the tendency has been to record more accurately and comprehensively than formerly, methods of building or manufacturing machines and mechanisms efficiently—that is, at the lowest cost commensurate with the required quality. There is a very good reason for this change.

The most important work of the machine designer is not merely to produce a mechanism that will function mechanically, but one that will meet this requirement and that also can be sold at a price which will insure for it a market. A widely known machine tool designer has said that anybody can design a machine to do almost anything, but that it takes real brains to design a machine that will do what is wanted at a reasonable cost.

This is one reason that accurate and complete information on shop methods and manufacturing procedure is so important. The successful machine designer must not only know how to design a machine or apparatus that will function according to mechanical laws, but he must also understand how the machine is to be built and how the parts are to be machined and assembled, so that every part incorporated in the machine will be so designed and arranged that it can be produced at the minimum cost. That is real machine designing, and in order to impart to designers this knowledge, publishers have brought out better literature on modern shop methods. The designer's needs have not been neglected thereby; they have been taken better care of.

Spring Meeting of Mechanical Engineers

AT the spring meeting of the American Society of Mechanical Engineers, held at Atlanta, Ga., May 8 to 11, mechanical engineering problems that are especially pressing for solution in the South were dealt with. A great deal of attention was given to the design, construction, and maintenance of textile machinery. A session of considerable interest in the machine-building field, relating to oxy-acetylene, electric, and forge welding methods, proved of great value to the engineers present. The technical program of the meeting was spread over three days and included two general sessions, two textile machinery sessions, and one session each on materials handling, fuels, power, management, and welding.

Investigations Relating to Oxy-Acetylene, Electric and Forge Welding

In a paper entitled "The Strength of Electrically Welded Pressure Containers," R. J. Roark of Madison, Wis., described pressure tests made on electrically welded, gas-welded, and riveted pressure containers, and tension and shear tests made on specimens cut from such containers and on specially prepared specimens of welded metal. The tests were made for the Vilter Mfg. Co., of Milwaukee, Wis., and had for their purpose the demonstrating of the strength and uniformity of construction in which the electrical weld is employed.

The results of the tests indicate that in containers of the type studied, electrically welded head joints are sufficiently strong to develop the full strength of the shell and heads; that it is practicable to make electrically welded joints which are uniform in respect to tensile strength, shearing strength, and structure of fused metal; that for the particular combination of metals tested, the tensile strength of such welded joints is about 28,500 pounds per square inch and the shearing strength about 25,500 pounds per square inch; that for the combination tested, the metal in the weld is less strong and less ductile than either the base metal or the filling metal before fusion; that the electrically welded joints tested were stronger in shear but weaker in eccentric tension than the riveted joints tested.

An extensive paper dealing with the principles of construction of unfired pressure vessels was prepared by S. W. Miller, of the Rochester Welding Works. In this paper the author discussed, in general terms, forge and fusion welding and riveting, and commented on the factors affecting welding efficiency. The composition of the best base weld metal and welding wire was touched on, and proper welding conditions were mentioned. The weakness of the single V-weld was pointed out, and the use of lower-tensile-strength material advocated. The question of relieving welding strains by annealing was also treated, these and the foregoing observations being all based on the practical experience of the author.

Professor E. A. Fessenden and Professor L. J. Bradford, both of State College, Pa., had prepared a paper giving the results of tests made on welded cylinders, in which four types of construction were referred to: (1) Flange-steel shell, acetylene-welded longitudinal seam, concave heads forge-welded to shell; (2) seamless-pipe shell, convex heads acetylene-welded to shell; (3) seamless-pipe shell, concave heads forge-welded to shell; and (4) flange-steel shell, acetylene-welded longitudinal seam, convex heads acetylene-welded to shell. This paper described the method of conducting the tests, presented the data obtained, and discussed the results. The authors concluded that vessels having forge-welded heads are the least reliable and that burnt steel is often present in the weld. They also stated that the principal defects in acetylene welds are the coarse granular structure and occasional porous spots and pin-holes that develop with high pressures, and poor adhesion of the welding material. Remedies for these defects were proposed.

Another paper of interest in connection with welding practice was that presented by Frank N. Speller, of the National Tube Co., Pittsburg, Pa., in which the principal factors—the method of manufacture, chemical composition, fluxing quality, susceptibility to heat and welding temperature—affecting the welding quality of steel were discussed and the average results of eighty tests made on forge welds of hammer-welded pipe, as compared with the original material were given. Tests have demonstrated that steel with not over 0.15 per cent carbon and a minimum tensile strength of 47,000 pounds per square inch, and with not over 0.20 per cent carbon and a minimum tensile strength of 52,000 pounds per square inch, is satisfactory for forge-welding of pipe lines, penstocks, tank-car work, and similar construction.

Care and Maintenance of Textile Machinery

The maintenance of textile machinery was dealt with in a paper by Edwin H. Marble, president of the Curtis & Marble Machine Co., Worcester, Mass., particular attention being called to the value of ball bearings in textile machinery, and the importance of proper lubrication. Reference was also made to a number of the common abuses of textile machinery and means suggested for preventing neglect in the care of this type of machines.

A paper on weaving machinery, by L. B. Jenckes of the Compton & Knowles Loom Works, Worcester, Mass., described in a general way the development of the weaving art, and dealt briefly with the most interesting developments in modern looms and the functions of parts of these machines.

The paper "Modern Shop Practice in the Building of Revolving Flat Cards," by F. E. Banfield, Jr., Newton Upper Falls, Mass., gave details of special machines developed for this work and showed how much the production cost per unit has been lowered by efficient shop arrangement, careful machine design, and standardization.

Material-handling Equipment

The material-handling equipment used in the iron and steel industry was dealt with in a paper read by F. L. Leach, of Perin & Marshall, New York City. This paper described the handling machinery and apparatus used in the manufacture of steel. From the time that the ore leaves the mines until the steel goes through the last process at the mill it is moved about by different types of heavy machinery designed especially for the purpose. The author expressed the hope that through his description, attention will be given to weak points in present-day practice and means of improvement be suggested.

Power and Fuel Session

The papers relating to power and fuel dealt with "Power Development in the Southeast"; "Economics of Water-Power Development"; "Hydro-electric Power-plant Design"; "The Accuracy of Boiler Tests"; "Boiler-room Performance and Practice of Colfax Station, Duquesne Light Co."; "The Control of Boiler Operation"; "Efficiency Tests of a 60,000-kilowatt Cross-compound Triple-cylinder Steam Turbine"; "Using Exhaust Energy in Reciprocating Engines"; and "Reduction of Fuel Waste in the Steel Industry."

Copies of any of the papers mentioned may be obtained upon application to the American Society of Mechanical Engineers, 29 W. 39th St., New York City.

The Gleason Works System of Bevel Gears*

By F. E. McMULLEN and T. M. DURKAN of the Gleason Works, Rochester, N. Y.

FOR a long time a need has been felt for a definite system of designing bevel gear teeth, which would give the most desirable tooth form for use under average conditions. It has been common practice in the past to use spur gear formulas, such as those of Brown & Sharpe, in figuring bevel gears. These formulas were worked out for an interchangeable spur gear system, which necessarily required some compromise, so that when they are applied to bevel gears, where interchangeability is not a factor, the possibilities of the involute curve are not fully utilized. The Gleason 0.3 and 0.7 long and short addendum tooth was brought out to improve this condition, and various other alterations of the standard spur gear design have been used, but for the most part these can be applied to certain combinations only, and therefore are not universal. Recent applications of bevel gearing covering a wide range of ratios have made it imperative that a system embracing all ratios and any number of teeth in common use, be worked out.

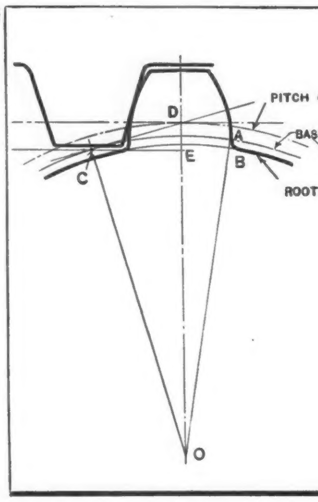


Fig. 1. Involute Tooth in Mesh with Rack

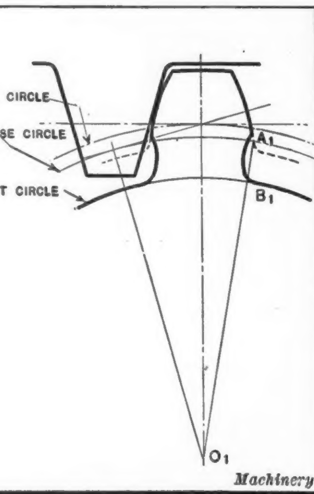


Fig. 2. Longer Rack Tooth and Resulting Under-cut

An investigation has been conducted by the Gleason Works with the idea of developing a practical system of designing the quietest form of tooth consistent with strength and wear considerations, and the results of this research have been incorporated in simple tabular form. This system applies to any pair of generated spiral or straight-tooth bevel gears operating at right angles where the pinion is the driver and has ten or more teeth. Bevel gears cut on former-type planers are the subject of a special study, as the system cannot be applied to such gears without modification.

Factors Governing Selection of Pressure Angle

The principal qualities considered in arriving at this system, arranged in the order of their importance, are quietness, strength and durability. In regard to quietness, experience shows that bevel gears cut with a lower pressure angle will operate more quietly than those with a higher one, other conditions being equal. There are several reasons for this: When the lower pressure angle is used, a greater arc of action is obtained, any eccentricity has less effect, and the radial component of the tooth load is minimized. Thrust forces also make it desirable to avoid the higher angle, not only because of the introduction of an axial or cone thrust not present in spur gears, but also because the majority of bevel gears are overhung from their supports, so the total load should be kept as low as possible. For these reasons the basis of the system is the use of the lowest pressure angle that can be employed without sacrificing strength by introducing excessive under-cut.

Under-cut in Connection with Bevel Gears

It might be well to describe what is meant by under-cut. In Fig. 1 is shown an involute tooth in mesh with a rack. The tooth profile consists of two parts, namely, the involute curve which has its origin at A and continues to the top of the tooth, and the fillet AB lying between the base and root circles. If the rack, which represents the generating tool, does not project below point C, beyond which involute action cannot take place, the fillet AB will always lie outside of a radial line OA drawn from the origin of the involute. When the rack tooth is made longer so that it extends below point C, the condition is as shown in exaggerated form in Fig. 2. In this diagram the fillet A_1 B_1 is seen to come inside of a radial line O_1 A_1 and also to cut away part of the involute curve slightly.

An examination of Fig. 1 shows that the value for dimension DE, which is the distance from C to the pitch line, is equal to the back cone radius $DO \times \sin^2$ pressure angle, so that a generated bevel gear tooth may be said to be under-cut when the dedendum is greater than the back cone radius $\times \sin^2$ pressure angle. However, it can be shown mathematically that it is possible to exceed this value consider-

*Abstract of a paper read before the American Gear Manufacturers' Association, April 22.

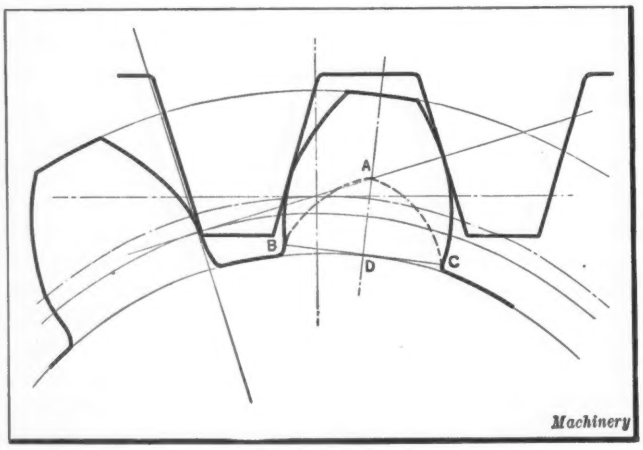


Fig. 3. Spiral Bevel Gear of 10—47-tooth Ratio and 14½-degree Pressure Angle

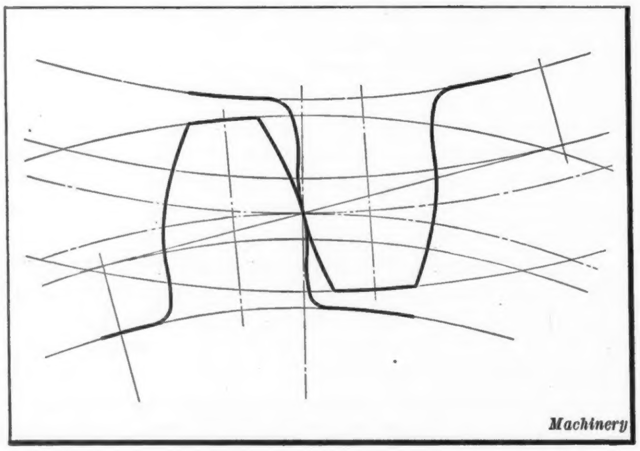


Fig. 4. Straight Bevel Gear of 14—16-tooth Ratio and 14½-degree Pressure Angle

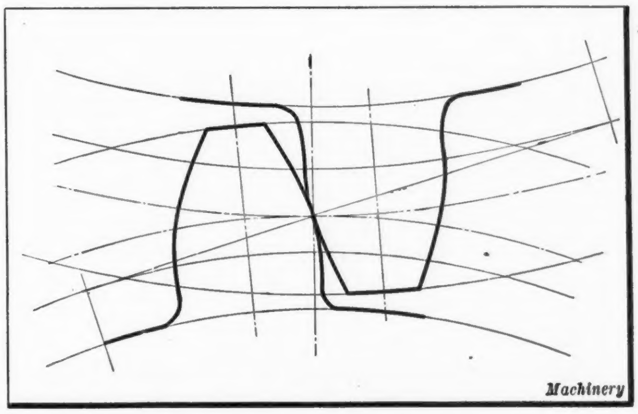


Fig. 5. Straight Bevel Gear of 14—16-tooth Ratio and 17½-degree Pressure Angle

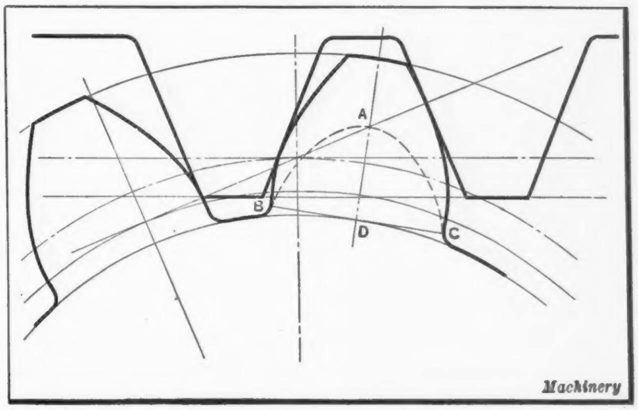


Fig. 6. Spiral Bevel Gear of 10—47-tooth Ratio and 20-degree Pressure Angle

ably before there is any appreciable under-cut; in fact, for the ordinary automobile rear axle pinion having anywhere from ten to thirteen teeth, the dedendum is nearly always more than this critical value, sometimes being as much as 100 per cent greater. The point at which to limit under-cut in the present system has been determined by a study of successful automobile practice, because that application represents a condition where both silence and strength are paramount.

The 10–47-tooth 14½-degree spiral bevel ratio shown in Fig. 3 has a pinion dedendum 60 per cent greater than the back cone radius × $\sin^2$ pressure angle, and although the under-cut is about as great as for any job in the spiral bevel system, it cannot be called excessive. Likewise, the 14–16-tooth 14½-degree straight bevel gears shown in Fig. 4 represent as extreme a case of under-cut as will be encountered in the straight-tooth system; yet they have a tooth profile which is not weakened to any great extent. The same ratio with a 17½ degree pressure angle is shown in Fig. 5, but the strength of the gears is increased less than 5 per cent, although it has the appearance of being more than this.

Pressure Angle and Strength

The selection of a low pressure angle in preference to a higher one does not result in a considerably weaker tooth, as is ordinarily supposed, because the stronger section of the higher pressure angle tooth is offset by the greater arc of action with the lower angle. Reference to Figs. 3 and 6 will make this clear. Fig. 3 shows a 10–47-tooth ratio with a 14½-degree pressure angle, and in Fig. 6 the same ratio is laid out with a 20-degree pressure angle. In each case the pinion tooth at the left is just on the point of engaging so that the tooth at the right is carrying the full load. This is the worst condition of loading on each tooth as any further movement to the right brings another tooth into contact, with consequent distribution of the load over two teeth, while movement to the left lowers the line of application of the force toward the base of the tooth.

In this position the comparative strength of the teeth can be found by passing a parabola through the intersection point A (See Figs. 3 and 6) of the line of action and the center line of the tooth, and tangent to the tooth profile. The value of $(BC)^2 \div AD$, which is a measure of the strength, can then be obtained. For the 10–47-tooth ratios shown in Figs. 3 and 6, the 20-degree gear is about 14 per cent stronger than the 14½-degree gear, but the pinions are of equal strength. The 20-degree gear, however, is much more difficult to caseharden on account of the narrow width of the top land. A pair of 15-tooth 14½-degree and another pair of 15-tooth 20-degree miter gears are shown in Figs. 7 and 8; here the 20-degree gear is less than 10 per cent stronger than the 14½-degree gear.

This method of calculating the strength is similar to that used in deriving the Lewis formula, except as regards the point of application of the load. The Lewis formula is based on the assumption that the load is applied at the end of the tooth, but in modern generated gearing this is a condition that practically never occurs. Professor Marx, in his experiments at Leland Stanford University, found that the force was not at the end of the tooth when failure took place, and also proved that the strength was increased as the arc of action became greater. From a consideration of these conditions, it is evident that the choice of a 14½-degree instead of a 20-degree pressure angle is not made at any extreme sacrifice of strength, but that for a large number of designs there is very little difference between the two.

Wear as Related to Sliding Action and Unit Pressure

The question of durability, viewed from a theoretical standpoint, would seem to resolve itself into a problem of obtaining a minimum of sliding and a maximum of rolling motion, as it is natural to assume that the wear would vary directly with the sliding action. But it is well known that the greatest wear often takes place near the pitch point where there is no sliding action. This is because the big factor causing wear is unit pressure and not sliding action. When the

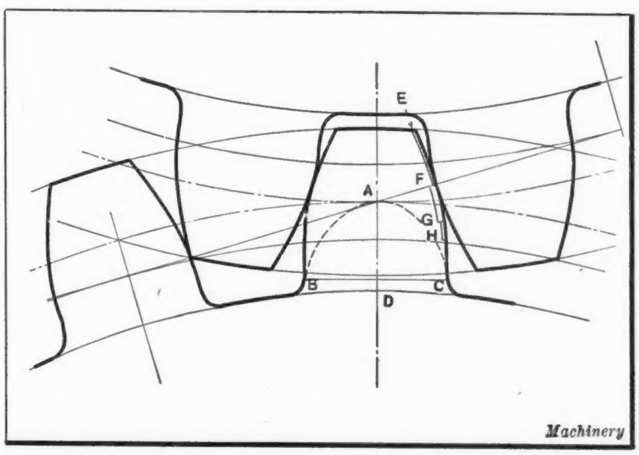


Fig. 7. Spiral Bevel Miter Gear, 15 Teeth, 14½-degree Pressure Angle

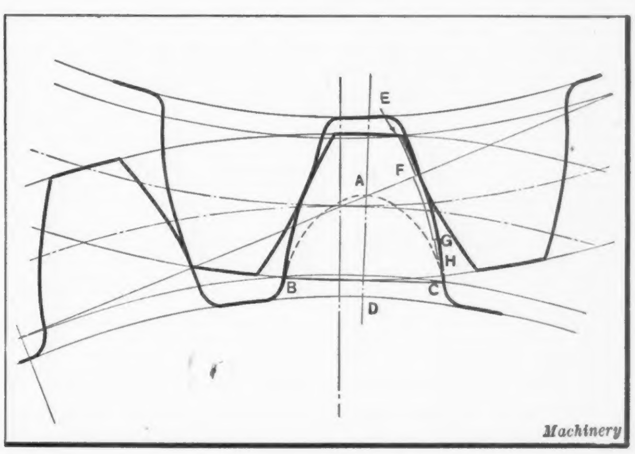


Fig. 8. Spiral Bevel Miter Gear, 15 Teeth, 20-degree Pressure Angle

TABLE 1. GLEASON WORKS SYSTEM FOR GENERATED STRAIGHT-TOOTH BEVEL GEARS

For Straight-tooth Bevel Gears Only, Operating at Right Angles, where Pinion is Driver and has Ten or More Teeth.

$$\text{Working Depth} = \frac{2.000''}{\text{D.P.}} \qquad \text{Full Depth} = \frac{2.188''}{\text{D.P.}}$$

Pressure Angle

	Deg.
Ratios having 14 or more teeth in pinion	14½
Ratios 13–13 to 13–24	17½
Ratios 13–25 and higher	14½
Ratios 12–12 and higher	17½
Ratios 11–11 to 11–14	20
Ratios 11–15 and higher	17½
Ratios 10–10 and higher	20

Addendum

$$\text{Addendum of gear} = \frac{\text{Addendum for 1 D.P. (Table 2)}}{\text{D.P}}$$

$$\text{Addendum of pinion} = \frac{2.000''}{\text{D.P.}} - \text{addendum of gear}$$

Dedendum

$$\text{Dedendum of gear} = \frac{2.188''}{\text{D.P.}} - \text{addendum of gear}$$

$$\text{Dedendum of pinion} = \frac{2.188''}{\text{D.P.}} - \text{addendum of pinion}$$

Circular Thickness

Circular thickness of gear for all ratios using 14½° =

$$\frac{1.071''}{\text{D.P.}} + \left[0.5 \times \text{addendum of gear}\right] - \frac{\text{K (Table 2)}}{\text{D.P.}}$$

Circular thickness of gear for all ratios using 17½° =

$$\frac{0.971''}{\text{D.P.}} + \left[0.6 \times \text{addendum of gear}\right] - \frac{\text{K}}{\text{D.P.}}$$

Circular thickness of gear for all ratios using 20° =

$$\frac{0.871''}{\text{D.P.}} + \left[0.7 \times \text{addendum of gear}\right] - \frac{\text{K}}{\text{D.P.}}$$

Circular thickness of pinion for 14½°, 17½° or 20° =

$$\frac{3.142''}{\text{D.P.}} - \text{circular thickness of gear}$$

Machinery

TABLE 2. GLEASON WORKS SYSTEM FOR STRAIGHT-TOOTH BEVEL GEARS

Addendum for 1 Diametral Pitch

To obtain addendum select from table value corresponding to ratio given by the formula:

$$\text{Ratio} = \frac{\text{Number of teeth in gear}}{\text{Number of teeth in pinion}}$$

Ratios		Add., Inch	Ratios		Add., Inch	Ratios		Add., Inch	Ratios		Add., Inch
From	To		From	To		From	To		From	To	
1.00	1.00	1.000	1.15	1.17	0.880	1.42	1.45	0.760	2.06	2.16	0.640
1.00	1.02	0.990	1.17	1.19	0.870	1.45	1.48	0.750	2.16	2.27	0.630
1.02	1.03	0.980	1.19	1.21	0.860	1.48	1.52	0.740	2.27	2.41	0.620
1.03	1.04	0.970	1.21	1.23	0.850	1.52	1.56	0.730	2.41	2.58	0.610
1.04	1.05	0.960	1.23	1.25	0.840	1.56	1.60	0.720	2.58	2.78	0.600
1.05	1.06	0.950	1.25	1.27	0.830	1.60	1.65	0.710	2.78	3.05	0.590
1.06	1.08	0.940	1.27	1.29	0.820	1.65	1.70	0.700	3.05	3.41	0.580
1.08	1.09	0.930	1.29	1.31	0.810	1.70	1.76	0.690	3.41	3.94	0.570
1.09	1.11	0.920	1.31	1.33	0.800	1.76	1.82	0.680	3.94	4.82	0.560
1.11	1.12	0.910	1.33	1.36	0.790	1.82	1.89	0.670	4.82	6.81	0.550
1.12	1.14	0.900	1.36	1.39	0.780	1.89	1.97	0.660	6.81	∞	0.540
1.14	1.15	0.890	1.39	1.42	0.770	1.97	2.06	0.650	......	....	......

Values of K for Circular Thickness Formula

Select value corresponding to number of teeth in pinion and ratio given by formula.

Number of Teeth in Pinion	Ratios 1.00 to 1.25	1.25 to 1.50	1.50 to 1.75	1.75 to 2.00	2.00 to 2.25	2.25 to 2.50	2.50 to 2.75	2.75 to 3.00	3.00 to 3.25	3.25 to 3.50	3.50 to 3.75	3.75 to 4.00	4.00 to 4.50	4.50 to 5.00	5.00 and higher
	Values of K (in Inches) for Different Ratios														
10	0.025	0.070	0.100	0.120	0.140	0.160	0.175	0.190	0.205	0.215	0.225	0.230	0.240	0.250	0.255
11	0.010	0.015	0.050	0.080	0.105	0.125	0.145	0.160	0.170	0.180	0.190	0.195	0.200	0.210	0.220
12	0.000	0.040	0.070	0.100	0.120	0.140	0.155	0.170	0.180	0.185	0.190	0.195	0.205	0.210	0.215
13	0.000	0.015	0.040	0.045	0.050	0.060	0.070	0.080	0.090	0.100	0.110	0.120	0.135	0.150	0.165
14	0.000	0.015	0.030	0.050	0.065	0.080	0.090	0.100	0.110	0.120	0.125	0.130	0.140	0.150	0.160
15 to 17	0.000	0.000	0.010	0.020	0.030	0.045	0.060	0.070	0.080	0.090	0.095	0.100	0.110	0.115	0.120
18 to 21	0.000	0.000	0.000	0.000	0.010	0.030	0.045	0.060	0.070	0.080	0.085	0.090	0.095	0.100	0.100
22 to 29	0.000	0.000	0.000	0.000	0.010	0.030	0.040	0.050	0.060	0.065	0.070	0.070	0.080	0.085	0.085
30 and up	0.000	0.000	0.000	0.000	0.010	0.025	0.035	0.040	0.045	0.050	0.055	0.060	0.065	0.070	0.070

Machinery

TABLE 3. GLEASON WORKS SYSTEM FOR GENERATED SPIRAL BEVEL GEARS

For Spiral Bevel Gears Only, Operating at Right Angles, where Pinion is Driver and has Ten or More Teeth.

$$\text{Working Depth} = \frac{1.700''}{\text{D.P.}} \qquad \text{Full Depth} = \frac{1.888''}{\text{D.P.}}$$

PRESSURE ANGLE

	Deg.
Ratios having 12 or more teeth in pinion	14½
Ratios 11–11 to 11–19	17½
Ratios 11–20 and higher	14½
Ratios 10–10 to 10–24	17½
Ratios 10–25 and higher	14½

ADDENDUM

$$\text{Addendum of gear} = \frac{\text{Addendum for 1 D.P. (Table 4)}}{\text{D.P.}}$$

$$\text{Addendum of pinion} = \frac{1.700''}{\text{D.P.}} - \text{addendum of gear}$$

DEDENDUM

$$\text{Dedendum of gear} = \frac{1.888''}{\text{D.P.}} - \text{addendum of gear}$$

$$\text{Dedendum of pinion} = \frac{1.888''}{\text{D.P.}} - \text{addendum of pinion}$$

CIRCULAR THICKNESS

Circular thickness of gear for all ratios using 14½° =

$$\frac{1.061''}{\text{D.P.}} + \left[0.6 \times \text{addendum of gear}\right] - \frac{\text{K (Table 4)}}{\text{D.P.}}$$

Circular thickness of gear for all ratios using 17½° =

$$\frac{0.976''}{\text{D.P.}} + \left[0.7 \times \text{addendum of gear}\right] - \frac{\text{K}}{\text{D.P.}}$$

Circular thickness of pinion for 14½° or 17½° =

$$\frac{3.142''}{\text{D.P.}} - \text{circular thickness of gear}$$

Machinery

point of contact is near the pitch point, all the load is borne by one tooth, while it is distributed over two teeth near the beginning or end of the action with a consequent reduction of unit pressure.

In Figs. 7 and 8 the part of the pinion profile that will wear most rapidly is *FG*, because it has to carry the whole load; *EF* and *GH* will not wear as fast, even though the sliding action is higher, on account of the lower unit pressure. For this reason no attempt has been made in this system to maintain any predetermined percentage of rolling action, but rather to balance, between approach and recess, the amount of rolling already fixed by the requirements of quietness and strength. Wherever possible, the action during approach has been favored in order to compensate for the change in direction of the friction component which tends to increase the obliquity of the line of action during approach and decrease it during recess. Account has also been taken of the high velocity of sliding action which occurs

TABLE 4. GLEASON WORKS SYSTEM FOR SPIRAL BEVEL GEARS

ADDENDUM FOR 1 DIAMETRAL PITCH

To obtain addendum, select from table value corresponding to ratio given by the formula:

$$\text{Ratio} = \frac{\text{Number of teeth in gear}}{\text{Number of teeth in pinion}}$$

Ratios		Add., Inch	Ratios		Add., Inch	Ratios		Add., Inch	Ratios		Add., Inch
From	To		From	To		From	To		From	To	
1.00	1.00	0.850	1.15	1.17	0.750	1.41	1.44	0.650	1.99	2.10	0.550
1.00	1.02	0.840	1.17	1.19	0.740	1.44	1.48	0.640	2.10	2.23	0.540
1.02	1.03	0.830	1.19	1.21	0.730	1.48	1.52	0.630	2.23	2.38	0.530
1.03	1.05	0.820	1.21	1.23	0.720	1.52	1.57	0.620	2.38	2.58	0.520
1.05	1.06	0.810	1.23	1.26	0.710	1.57	1.63	0.610	2.58	2.82	0.510
1.06	1.08	0.800	1.26	1.28	0.700	1.63	1.68	0.600	2.82	3.17	0.500
1.08	1.09	0.790	1.28	1.31	0.690	1.68	1.75	0.590	3.17	3.67	0.490
1.09	1.11	0.780	1.31	1.34	0.680	1.75	1.82	0.580	3.67	4.56	0.480
1.11	1.13	0.770	1.34	1.37	0.670	1.82	1.90	0.570	4.56	7.00	0.470
1.13	1.15	0.760	1.37	1.41	0.660	1.90	1.99	0.560	7.00	∞	0.460

VALUES OF K FOR CIRCULAR THICKNESS FORMULA

Select value corresponding to number of teeth in pinion and ratio given by formula.

Number of Teeth in Pinion	Ratios														
	1.00 to 1.25	1.25 to 1.50	1.50 to 1.75	1.75 to 2.00	2.00 to 2.25	2.25 to 2.50	2.50 to 2.75	2.75 to 3.00	3.00 to 3.25	3.25 to 3.50	3.50 to 3.75	3.75 to 4.00	4.00 to 4.50	4.50 to 5.00	5.00 and higher
	Values of K (in Inches) for Different Ratios														
10	0.020	0.055	0.085	0.105	0.125	0.125	0.110	0.120	0.130	0.140	0.150	0.155	0.160	0.170	0.180
11	0.030	0.075	0.105	0.070	0.085	0.095	0.105	0.115	0.125	0.135	0.140	0.145	0.150	0.155	0.160
12 to 13	0.005	0.015	0.025	0.035	0.045	0.055	0.065	0.075	0.085	0.095	0.105	0.115	0.125	0.135	0.135
14 to 16	0.000	0.005	0.015	0.025	0.035	0.050	0.060	0.075	0.085	0.095	0.100	0.105	0.105	0.105	0.105
17 to 19	0.000	0.000	0.005	0.015	0.025	0.035	0.050	0.065	0.075	0.085	0.090	0.090	0.090	0.090	0.090
20 and up	0.000	0.000	0.000	0.005	0.015	0.025	0.040	0.050	0.055	0.060	0.060	0.060	0.060	0.060	0.060

Machinery

at the top of long addendum pinion teeth and which, in extreme cases, has led to abrasion. Safe values for this sliding action were obtained from jobs in service and the design regulated so that these were not exceeded.

How the System was Established

In establishing the various factors that go to make up the system, the aim was to arrange them in as simple and practicable a form as possible without sacrificing any of the three principal qualities of quietness, strength, and durability. In a non-interchangeable system like the one here presented, any of the factors can be made to vary for each ratio and number of teeth, but simplicity and the interests of standardization are opposed to expressing these factors as variable quantities when the probable accuracy of the assumptions made in determining them does not warrant it.

An example of this is the pressure angle. In a purely theoretical system it might have any value, while the same practical results are obtained in this system, which includes all ratios having ten or more teeth in the pinion, with the use of three angles (14½, 17½, and 20 degrees) for straight-tooth bevel gears and one angle (14½ degrees) in all except a few unusual cases, for spiral bevel gears. The pressure angle to be used for any given pair of gears is specified in Tables 1 and 3, and has been selected as the lowest angle which avoids excessive under-cut.

The introduction of the pressure angle of 17½ degrees, which is not universally used, is considered necessary in order to carry out the stated purpose of developing a practical system which will give the quietest form of tooth consistent with strength and wear. It has been found by experience that there is a decided increase in noise when the pressure angle is changed from 14½ to 20 degrees, so that in order not to compromise the system when the under-cut becomes too great with 14½ degrees, an intermediate pressure angle is used. The angle of 17½ degrees has been selected because it has already been used to quite an extent by different gear manufacturers. Although at least one pressure angle between 14½ and 20 degrees is required, more are unnecessary because any new angle would not be more than 1½ degrees different from the three selected, and this change is too small to have any practical effect.

Working Depth and Clearance

The working depth of tooth, which has been fixed as 2 inches ÷ diametral pitch for straight-tooth bevel gears and as 1.7 inches ÷ diametral pitch for spiral bevel gears, is the same as has been successfully used for a number of years. For the average spiral angle of about 30 degrees, the normal pitch is approximately 85 per cent of the linear pitch, so the normal section of a spiral tooth will be proportioned about the same as a straight tooth. Originally the working depth for both straight and spiral bevel gears was made equal to 2 inches ÷ diametral pitch, but some years ago the depth for spiral bevel gears was decreased to 85 per cent of this amount, because the top of the tooth on the normal was too thin and gave rise to hardening troubles. Stubbing the tooth more than 85 per cent decreased the arc of action and gave a noisier gear. It would be desirable from the standpoint of standardization to use the same working depth for straight-tooth bevel gears as for spiral bevel gears, but after considerable experimenting along this line, it was found that straight bevel gears having an 85 per cent stub tooth were noticeably noisier in operation than similar gears with the full depth tooth. For this reason the standard of 2 inches ÷ diametral pitch has been retained for straight-tooth bevel gears.

The bottom clearance which is specified in the system is 0.188 inch ÷ diametral pitch (0.06 × circular pitch) and is the minimum amount which experience shows is necessary for the average job to insure against bottoming of the teeth. In the past 0.05 × circular pitch has been used and found to be insufficient, while 0.07 × circular pitch which has also been tried out, is more than is required.

Addendum and Circular Thickness

The method followed in proportioning the addendum and dedendum was to adjust them until the amount of sliding during approach was about the same or slightly less than the sliding action during recess. This also had the effect of making the arc of recess greater than the arc of approach, which is very desirable, since recess action is quieter than approach. To obtain these conditions, it was necessary to decrease the gear addendum and increase the pinion addendum as the ratios of the numbers of teeth in the gear and pinion became greater. These values of addendum for gear and pinion were originally worked out for each ratio and number of teeth, and from an examination of them it was found possible to make an arrangement in a simple tabular form according to ratios (see Tables 2 and 4) without any sacrifice of practical qualities.

Circular thickness was found entirely by making enlarged lay-outs in which the teeth were balanced up partly on a width of top land and partly on a strength basis. The formulas given in Tables 1 and 3 were worked out so that they would give the same results that were obtained from the lay-outs.

This system is not new or untried, but in the case of spiral bevel gears, at least, is represented in practice by a large number of very satisfactory jobs. It also checks up closely with successful straight-tooth bevel gear practice, although the long and short addendum tooth has not been used as universally for straight-tooth bevel gears as for spiral bevel gears. The system, as presented, represents in a simple and usable form an intensive study of the question of bevel gear tooth design, treated from both a practical and a theoretical standpoint.

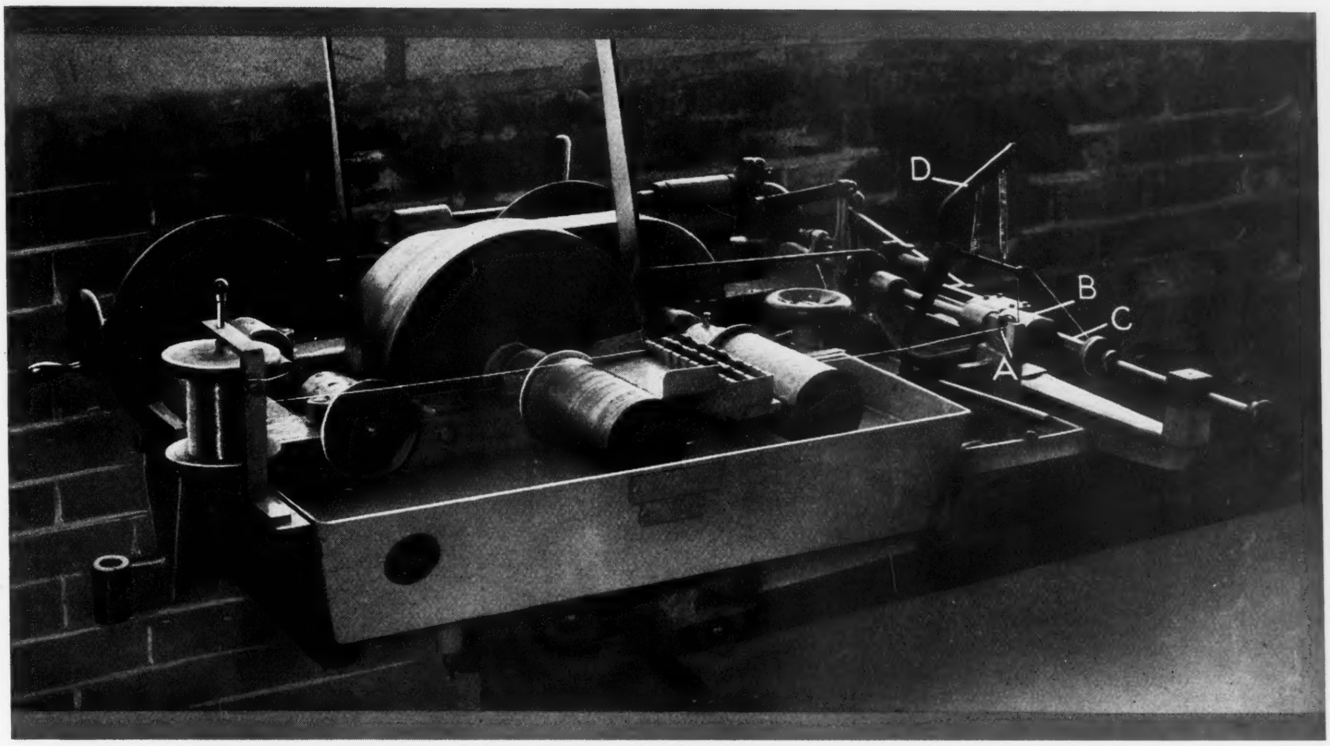
It might not be out of place to express the opinion that a standard non-interchangeable system, possibly along similar lines to the one presented, is needed for spur gears. In fact such a system should be of as great importance as a standard interchangeable system, since a large proportion of spur gears, like bevel gears, are intended to operate in pairs only. The concessions made to allow interchangeability are so great that the case of the non-interchangeable gear should be granted as much consideration in the way of a standard system as is given to the interchangeable gear.

* * *

NEW SAFETY CODE FOR ABRASIVE WHEELS

A new safety code for the use, care, and protection of abrasive wheels has recently been approved by the American Engineering Standards Committee. This code has been in the process of preparation for about two years. It was prepared under the rules of procedure of the American Engineering Standards Committee, and has as its sponsors the International Association of Industrial Accident Boards and Commissions and the Grinding Wheel Manufacturers Association of the United States and Canada. These sponsors appointed a sectional committee to draft the code, consisting of twenty-eight members representing various branches of both federal and state governments, several national manufacturing associations, a number of individual employers, associations of employes using grinding wheels, several technical societies, and insurance associations.

The code gives rules and specifications necessary to insure safety in the use of abrasive wheels operating at speeds in excess of 2000 surface feet per minute. It deals with types of protection devices, storage and inspection of wheels, general machine requirements, protection hoods, work-rests, protection of wheels, flanges, mountings, speeds, operating rules, and general data. Copies may be obtained from any grinding wheel manufacturer or from the American Engineering Standards Committee, 29 W. 39th St., New York City.



Drawing Chromel Wire

Methods of Drawing Special Alloy Wire, Uses and Physical Properties of the Alloy, and Manufacture of the Dies

By E. F. LAKE

CHROMEL is the trade name for a high-grade alloy containing, in its best grade, 80 per cent nickel and 20 per cent chromium. Another grade contains 85 per cent nickel and 15 per cent chromium, while still a third grade contains approximately 61 per cent nickel, 25 per cent iron, 3 per cent manganese, and 11 per cent chromium. All other elements are classed as impurities and are held down to a minimum. Chromel alloys have an electrical resistance from fifty to sixty-five times greater than that of copper, depending on the grade of the alloy, and they also have a very high resistance to heat. The best grade is practically immune to oxidation and corrosion at temperatures up to about 2200 degrees F. The third grade, however, which contains iron, begins to oxidize at about 1500 degrees F., and this oxidation increases with the rise in temperature. Chromel is made by the Hoskins Mfg. Co., Detroit Mich.

The behavior of this alloy under high temperatures makes it suitable for use as a heating element in all kinds of electrically heated devices, from electric toasters to furnaces used for heating steel preparatory to hardening or forging. Iron-free chromel may be found in use in the thermocouples of nearly all pyrometers that work at a temperature up to 2200 degrees F. This alloy is said to be mainly responsible for the rapid growth of the electric heating industry in which it is used for heating apparatus that operates at temperatures between 1500 and 2200 degrees F. The third grade of the alloy, in which iron is an ingredient is used extensively in the construction of flat-irons, ovens, and heating devices that operate below a temperature that does not exceed the oxidizing point of the alloy. Although the alloy has many other important applications, those mentioned are the most common uses for wire that is drawn by the methods described in this article.

In the manufacture of wire, chromel is first melted and mixed in the induction-type electric furnace until all impurities are removed. It is next cast into ingots 4 inches square and 24 inches long. These ingots are reheated to about 2200 degrees F., after which they are rolled into bars 2½ inches square in four passes through the rolls. The end of these bars is then cropped off to remove the pipe, and the bars are again heated and rolled into 1¼-inch squares, in six passes. Each of these bars is next cut into two lengths, and the imperfect ends are cropped off. Then the bars are heated again and rolled to ¼-inch diameter round wire in ten passes, after which the wire is coiled. This hot-rolled wire is then reduced to smaller sizes and sectional shapes by cold rolling and drawing, bull plates and diamond dies being used in the latter operation.

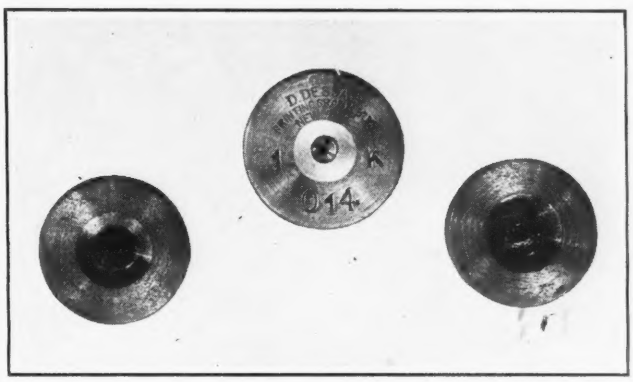


Fig. 1. Diamond Dies used in drawing Chromel Wire

In Fig. 1, three diamond drawing dies in different stages of completion are shown. The diamonds used

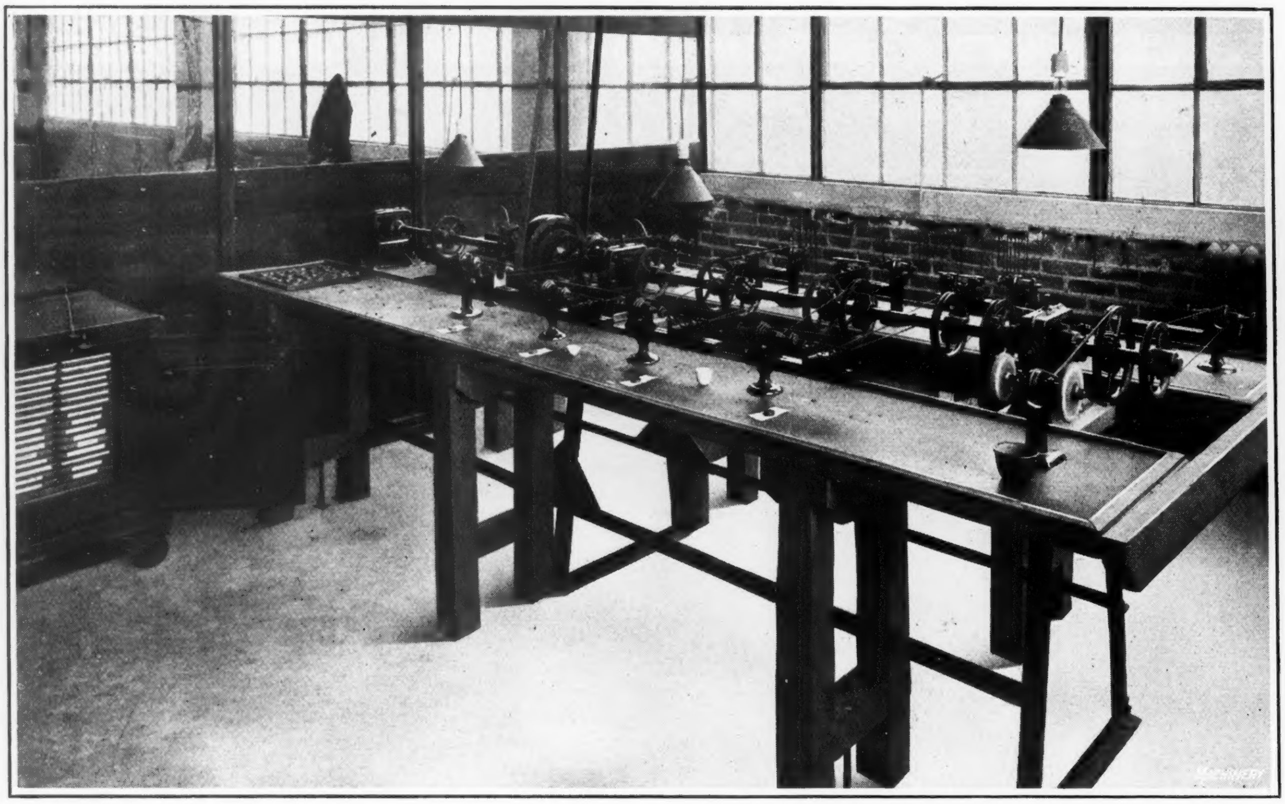


Fig. 2. Corner of the Diemaking Room where the Drawing Hole is lapped through the Diamonds

range in weight from 1/6 to 1/3 of a carat for the smaller sizes of wire up to from 4½ to 5 carats for the larger sizes. Chromel wire that is produced by drawing through diamond dies is not made larger than No. 16 gage (0.051 inch). As the size of the wire increases, the amount of reduction in diameter at each drawing becomes greater. This causes the diamond to be subjected to a greater strain, so that if it is too small it will split through the center of the drawing hole. The amount of reduction per die, as a general rule, is 0.0005 inch when drawing from 0.002- to 0.0015-inch wire; 0.001 inch when drawing 0.005-inch wire; 0.002 inch when drawing 0.020-inch wire; and 0.004 inch when drawing wire 0.051 inch in diameter, which is the largest drawn size. Diamonds that are poor in color or that contain flaws are as suitable for this work as perfect stones, provided the flaws do not interfere with the making of a true drawing hole. Black diamonds are considered best, but the white or Bortz diamonds often give as good results and are much cheaper.

Making the Diamond Drawing Dies

The making of diamond dies for steel wire drawing is work that requires a great deal of care. A description of one method of making these dies was published in November, 1919, MACHINERY. However, a somewhat different and more accurate manufacturing process is required when the dies are to be used for the drawing of chromel alloy wire. The procedure in making diamond dies for this class of work is briefly described in the following paragraphs:

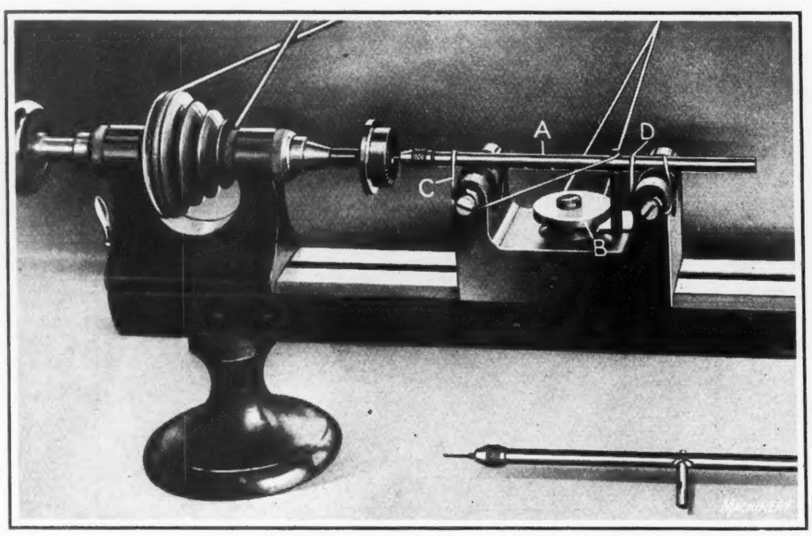


Fig. 3. Set-up of Bench Lathe used in lapping the Drawing Hole in the Diamond

The rough diamonds are set into brass die-holders and temporarily held by means of shellac while a conical center for the drawing hole is being cut. An oxy-acetylene torch is then used to braze around the diamond, which results in filling the hole surrounding the diamond, as shown in the dies to the right and left in Fig. 1. The surface of the brass holder is then ground, to smooth off the brazing so that the die will present a flat surface from which it may be located on the surface plate of a lathe while the drawing hole is being finished. This assures that the hole will be square with the face of the die-holder. A finished drawing die is shown in the center of Fig. 1, the lighter color around the diamond indicating the metal added in brazing.

Finishing the Hole in the Diamond

An installation of a number of bench lathes used both for roughing the holes in the diamonds and for the final finishing work is shown in Fig. 2. At one end of the front bench is located a tool grinder, by means of which the fine-pointed lapping tools are ground to within the extremely close limit of 0.0001 inch that is required. The tools, being common needles, are of such small size that in grinding, a man must wear a magnifying eye-glass. At the opposite end of this bench is shown a tray of diamond dies which are in the process of manufacture; these trays are kept in the safe adjacent.

A close-up view of one of these lathes is shown in Fig. 3; here a diamond die is shown centered on the faceplate, to which it is held by shellac. Shellac is

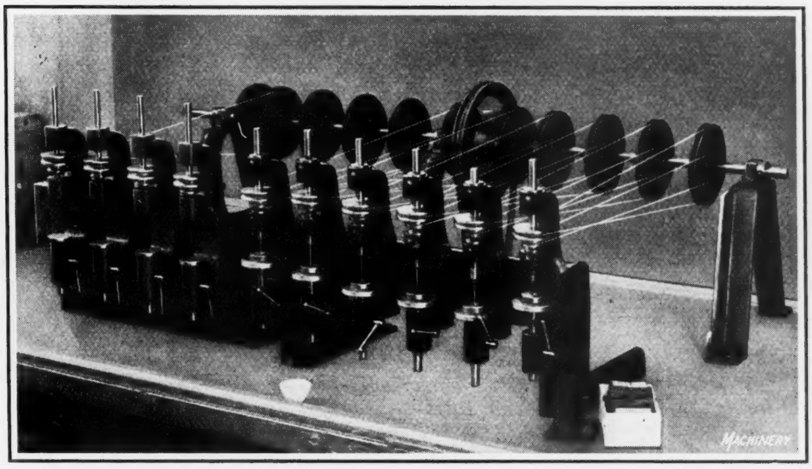


Fig. 4. Multiple-spindle Machines for bell-mouthing both Ends of the Tapered Drawing Hole

a suitable holding medium, as there is no great torsional strain produced while the hole is being lapped through the diamond. The tool used in producing this hole, as stated, is a common sewing needle. The needle is chucked in the end of tool-holder *A* which rests in two V-pulleys supported in the tailstock. The tool is charged with a thin paste of diamond dust and oil, and as the faceplate revolves, the tool-holder moves the needle lap in and out of the hole that is being produced in the die. The reciprocating motion that is imparted to the tool-holder is produced by cam *B* which is driven by a belt from the lineshaft. A vertical post on this tool-holder is held against the cam, and the tool-holder is held down in the front V-pulley by a rubber band *C*. Another rubber band *D* keeps the holder on its seat in the rear V-pulley.

This simple arrangement makes the lapping of the holes through the diamond practically automatic, except for the work of charging the needle lap with diamond dust paste. These machines require so little attention that one man and a helper can easily attend to the nine lathes shown in Fig. 2, and also take care of the machines shown in Fig. 4, while attending to the other work needed in this department. Although the set-up of the lathe appears to be comparatively simple, the required accuracy is maintained, and break-downs seldom occur. The efficiency of the rubber bands is notable; they last for weeks and sometimes months, and if one breaks it can be replaced without delay.

Bell-mouthing the Drawing Hole

The hole produced by the needle lap is tapered and is enlarged at both ends to a slight curve. The wire to be drawn is passed through from the large end of this hole, and the diameter at the small end governs the finished size of the wire and must be held to within limits of 0.0001 inch of the required size. The bell-mouthing is done by the multiple-spindle machines illustrated in Fig. 4.

These bench machines for bell-mouthing the holes are motor-driven, the spindle which carries the needle lap being revolved while the diamond die is held stationary on the platen of the machine. The dies are properly centered relative to the spindle and held in position by shellac. Provision is made for raising and lowering the platen to bring the die up to the needle lap. Directly beneath the pulley on the spindle there is a side cam by means of which the spindle is reciprocated during the performance of the operation. This raises the needle lap on every third revolution of the spindle so that the diamond dust paste, with which the tool is charged, can flow into the hole being countersunk. It will be noticed that the cam is driven by a different belt from that used for revolving the spindle of the machine. These machines are also practically automatic, and after being properly set up they run for hours without further attention.

Drawing the Wire

Fig. 5 shows a machine used for drawing chromel wire. This is a twelve-die machine, five diamond dies *A* being located in the front row and six similar dies in the rear row, the final finishing die being located at *B*. As the drum *C* revolves it draws the wire through the machine from a reel at the opposite end, from which it passes around pulleys, through a tripping lever guide near the floor (see Fig. 6) and over and around rolls *D* and *E*, Fig. 5. Each of the twelve dies reduces the wire in a progressive ratio, until the finished size is produced by die *B*. On this machine the twelve dies reduce the wire size from 0.051 inch (No. 16 gage) to 0.020 inch (No. 24 gage). Obviously, wire can be drawn to any intermediate size by the selection of the proper drawing dies.

The first diamond die through which the wire passes is located in the front row, at the extreme rear. This die reduces the diameter of the wire 0.004 inch, and this amount of reduction decreases with each succeeding die until the reduction produced by the last die in the two rows through which the wire passes is but 0.002 inch. From this die, which is located at the front of the rear row, the wire is passed through the finishing die, which reduces it only 0.001 inch in diameter. The base of the machine is filled with soapy water in which the rolls *D* and *E* revolve while the wire is being drawn, so that both the dies and the wire are thoroughly lubricated.

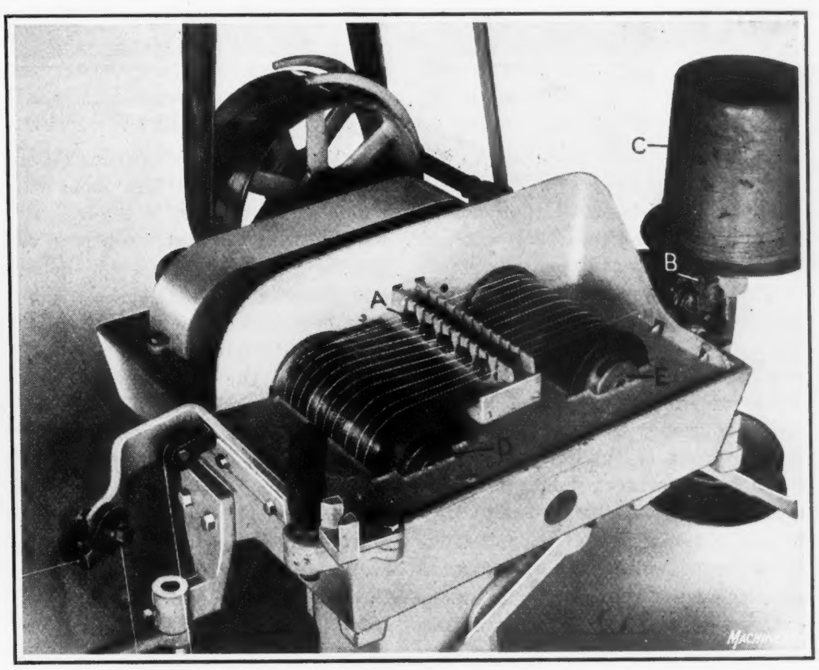


Fig. 5. Wire-drawing Machine, showing Course of Wire during its Passage through the Dies

Another wire-drawing machine of similar construction is shown in Fig. 6, but in this case only one die is used in addition to the finishing die. The tripping mechanism, as well as the manner of passing the wire through a pulley on the tripping lever, is clearly illustrated. Before passing the wire over the rolls and through the dies it is strung from the reel to the weighted lever near the base of the machine. If the wire

should become tangled, the tension produced by the drum at the opposite end of the machine will cause the wire to raise this lever, which in turn, will throw out a clutch and stop the machine, preventing breakage. After the wire has been drawn on the machines described, it is made ready for the market by winding on spools. This work is done on automatic machines that wind ten spools at a time. Provision is made on the winding machine for regulating the travel of the rear shaft back and forth to correspond to the length of the spool. The wire is fed on the spool through a holder on this reciprocating shaft, and is thus wound on the spools in even layers.

Rolling Ribbon Stock

Ribbon stock is made by rolling round wire flat in machines similar to that shown in Fig. 7. The ribbon stock varies in size from 0.002 inch thick by 1/64 inch wide to 0.035 inch thick by 1.16 inches wide, and machines of the type shown are used for all sizes. Obviously the larger sizes would require a more powerful machine than that used for the small wire, and when the stock is so heavy that it enters the bar class, it is flattened by hot-rolling. The rolls of the machine illustrated are 4 inches in diameter and 6 inches long, and are made of the best grade of steel that can be obtained. They are properly hardened so that they will not become grooved quickly from the high compressive stresses produced in cold-rolling. The wire thus flattened is rolled to within limits of 0.0001 inch of its specified size on this machine.

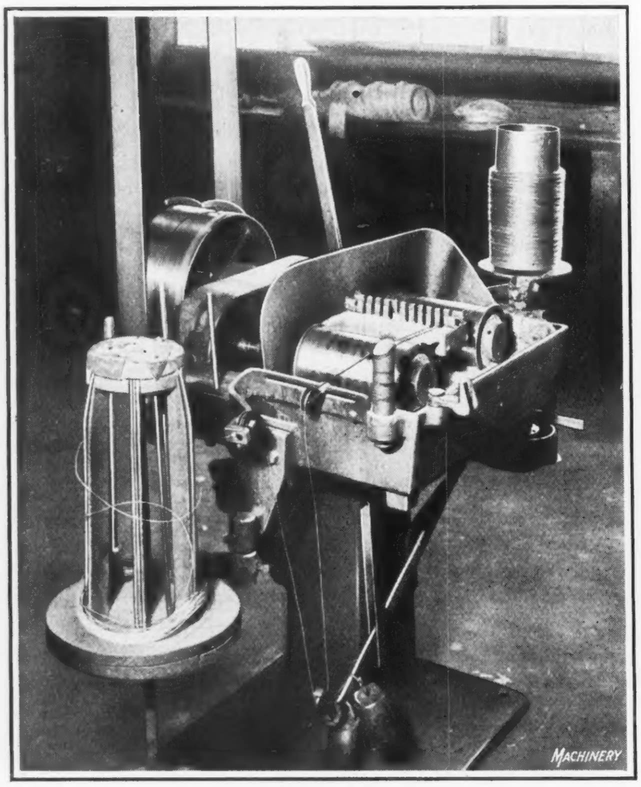


Fig. 6. Another Wire-drawing Machine, showing Automatic Arrangement for stopping

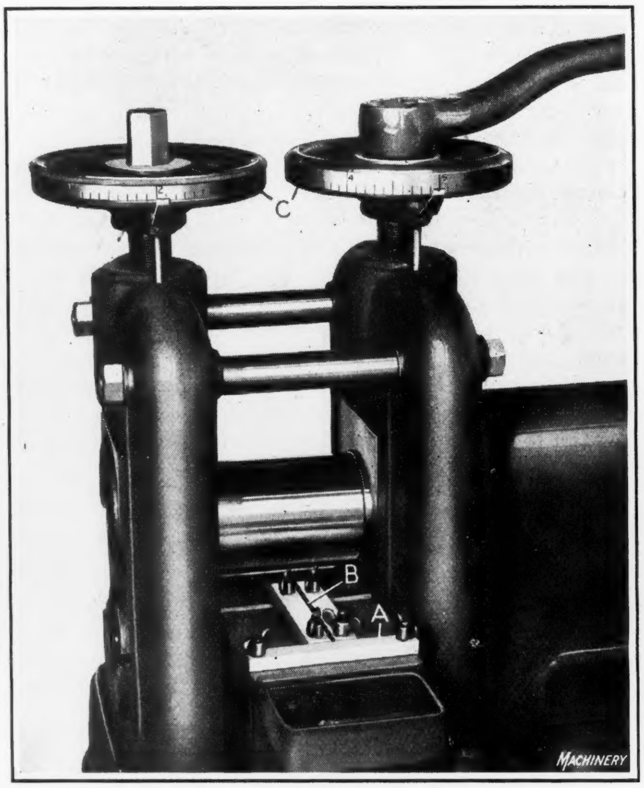


Fig. 7. Type of Machine employed for rolling Circular Wire into Flat Ribbon Stock

The wire must be passed through the rolls at a proper tension, otherwise it will enter the rolls crooked and be fed in jerks. For obtaining the proper tension, the wire is strung from a reel located in front of the rolls around a number of small pulleys and a series of grooved rolls in a more or less zigzag manner. These grooved rolls are located on a plate that is fastened to the machine at *A*, and from these rolls the wire passes between guides *B*, the position of which may be adjusted laterally on the platen so as to enable the entire face of the rolls to be used before it becomes necessary to regrind them. Regrinding is periodically necessary in order to remove the depressions that are worn into the face of the rolls.

Graduated dials *C* enable the top roll to be adjusted to obtain the proper thickness of stock. The graduations on these dials are 1/8 inch apart, and each graduation corresponds to a movement of the upper roll of 0.001 inch so that each end of the roll may be accurately adjusted to bring the face of the top roll parallel with that of the bottom roll. If the rolls are not set absolutely parallel, the ribbon stock will be rolled curved and must be scrapped. In addition to this means for obtaining accurate setting of the rolls, a microscope is always used on the stock itself, which is the most reliable means of furnishing a direct knowledge of its exact thickness.

Machine for Drawing and Winding the Wire Simultaneously

The larger machines used in drawing chromel wire have no provision for winding the wire on spools, but the smaller sizes of wire are drawn and automatically wound on spools by means of the machine shown in the heading illustration. This machine has provision for three instead of two rolls, and fifteen drawing dies instead of the twelve used on the larger machines. The set-up shown in the illustration is for drawing the wire through nine diamond dies, reducing it from 0.2 inch to 0.0015 inch, which is the smallest size in which chromel wire is made. An idea of the size of this wire will be obtained when it is realized that it takes about 212,000 feet or approximately 40 miles of this wire to weigh one pound. One-quarter of a pound, or 53,000 feet of this wire is wound on each spool, and there are seldom more than five breaks in the entire length. Four dies are arranged in each of the rows, as shown, and the finishing die is located at *A*, this die reducing the wire only 0.0005 inch in diameter. If necessary, additional dies up to the maximum of fifteen may be provided, but as many reductions as this are not often made.

The wire is wrapped around the roll *B*, which revolves and produces most of the tension on the wire. The spool *C* on which the wire is wound exerts just enough pull to keep the wire in tension so that it will wind correctly. After traveling around roll *B*, the wire passes up through guide *D* and down around the spool. The shaft on which the spool is carried is given a reciprocating motion so that as it revolves the wire will be wound in even layers. The rate of traverse

of the shaft can be regulated to accommodate different sizes of wire.

Difficulties Encountered in Chromel Manufacture

In making chromel wire certain difficulties are encountered that are not met with in making other metals or alloys. Impurities seem to affect this alloy to a greater degree than others. Oxidation, and particularly corrosion, must be guarded against if the alloy is to have a long life at the high temperatures at which it is used. It has been shown by experience in drawing chromel wire that excessive hydrogen in the alloy is responsible for undue breakage. Carbon also makes the alloy brittle, and has to be reduced to traces. Any of the ingredients classed as impurities reduce the heat resistance and electrical resistance of chromel alloy (which are its two most valuable characteristics) and also increase the difficulty of drawing the wire into fine gage sizes.

At one time only pure chromium and nickel were used in making the alloy. However, the chromium need not be entirely free from carbon, as any small percentages contained in it will burn out in the electric furnace during the melt. At first it was thought that electrolytic nickel was absolutely pure, and was therefore most suitable, but it was found that the electrolytic process of manufacture caused the nickel to absorb some hydrogen. This necessitated the use of a small percentage of "shot nickel" for the purpose of reducing the hydrogen of the electrolytic nickel. It has been observed that one English method of making pure nickel, in which the electrolytic process is not used, produces a nickel that is practically free from hydrogen, so that when this nickel enters into the manufacture of chromel, "shot nickel" is not required. This is an advantage, as there is always the danger of introducing other impurities when shot nickel is used.

The iron-chromel must contain the purest iron obtainable, for the inferior grades introduce other impurities that are objectionable, such as sulphur, phosphorus, oxygen, and hydrogen, which are difficult to remove. It may be proper to add in conclusion that this alloy can be readily cast and forged, which adds greatly to its commercial value.

* * *

COMMITTEE ON STANDARDIZATION OF MACHINE TOOLS

Through the cooperation of the American Society of Mechanical Engineers and the National Machine Tool Builders' Association, a committee will be formed consisting of five representatives of the mechanical engineers and five machine tool builders, to work on machine tool standardization problems. The activities of the committee will be carried on under the auspices of the American Engineering Standards Committee, and will relate particularly to the work- and tool-holding parts of lathes, planers, milling machines, drilling machines, grinding machines, power presses and boring mills. Of the representatives appointed by the National Machine Tool Builders' Association, one each will be drawn from one of the groups of manufacturers of the following types of machine tools: Planers; grinding machines; punching and forming machines; machines, using cutting tools, in which the work revolves; and machines, using cutting tools, in which the tool revolves.

Dealers are asked to cooperate by making suggestions to the committee, and the assistance of users is particularly invited, as under the rules of the American Engineering Standards Committee, representatives of three groups must always be consulted in the adoption of standards—producers, consumers, and general interests. Those interested in this matter are requested to communicate either with E. F. DuBrul, general manager of the National Machine Tool Builders' Association, 817 Provident Bank Bldg., Cincinnati, Ohio, or with C. B. LePage, assistant secretary of the American Society of Mechanical Engineers, in charge of standardization committee work, 29 W. 39th St., New York City.

THE INDUSTRIAL ASSOCIATION OF CLEVELAND

Herbert Hoover has said, "A definite and continuous organized relationship must be created between the employer and the employe; by the organization of this relationship, conflict in industry can be greatly mitigated, misunderstandings can be eliminated, and that spirit of cooperation can be established that will advance the condition of labor and secure increased productivity."

Recognizing the value of affording an opportunity for personal contact between industrial employers and employes, aside from their daily contact in manufacturing plants, industrial leaders of Cleveland have established an organization known as the Industrial Association of Cleveland. Its object is educational, the main purpose being to improve industrial conditions. It is believed that the problems confronting industry can be solved by constructive thinking, and it is to stimulate such thought that this institution was founded.

There are two classes of membership, employers and employes. Employer memberships are held by individuals, firms, or corporations, the cost varying according to the number of men employed. Employe memberships cost $5 a year. One of the principles of the association is to keep a balance between the number of employer and employe members. In addition, there is an associate membership for those who are not eligible for either of the full membership classes. Associate members have all the privileges of those in the employer or employe class except that they cannot vote. The membership is open to any employe over eighteen years of age who is interested in promoting industrial prosperity and the ideals for which the association stands. All classes of industry represented in Cleveland are eligible for membership in the association.

Educational Activities of the Association

In line with the educational functions of the Industrial Association of Cleveland, a business training course is maintained to afford an opportunity for instruction in the fundamentals of business. The course for 1922 includes a comprehensive survey of modern business organization and methods. Leaders in their respective fields in the business and professional world have spoken on the following subjects: Economics of business; business plans; finance; organization; plant engineering; advertising; sales and marketing; production engineering; production and control of materials; inspection; shipping; purchasing; accounting and cost finding; credits and collections; commercial law; and maintenance and repairs.

In addition to these lectures, various educational courses are provided to give employe members of the association an opportunity to improve themselves in different departments of business training in which they are interested. For instance, there is a course in stenography, and the business training course mentioned, which has an enrollment of 300. These courses are run on a cooperative basis so that the training is obtained at a comparatively low cost. A number of clubs are also maintained in conjunction with the association, among which may be mentioned the Executives Club, composed of managers and foremen, the Inventors Club, the object of which is to further the interests of men with patentable ideas, and the Faneuil Club, which affords training in public speaking.

The foregoing is by no means a complete account of the activities of the Industrial Association of Cleveland, but it gives a general idea of the work which is being accomplished. In the words of H. B. Bole, the first vice-president of the Hydraulic Steel Co., Cleveland, who is this year's president of the Industrial Association, "The success of the organization is based upon a sincerity of purpose which makes itself actually felt, added to the fact that the organization is based on the sound principle of mutual understanding."

DIRECTIONS FOR USING CHART

To find the horsepower per inch of face width, trace on a horizontal line from the style of tooth desired, to the diagonal line representing the pitch; then trace on a vertical line to the diagonal line representing the velocity in feet per minute; then trace on a horizontal line to the right-hand side of the chart thus obtaining the number of horsepower per inch of face width for either forged steel, cast steel, bronze, cast iron rawhide or micarta.

To find the tooth load at "zero speed" per inch of face width, trace on the horizontal line from the style of tooth desired to the pitch line; then trace on the vertical line to the top of the chart for the tooth load for any of the materials listed.

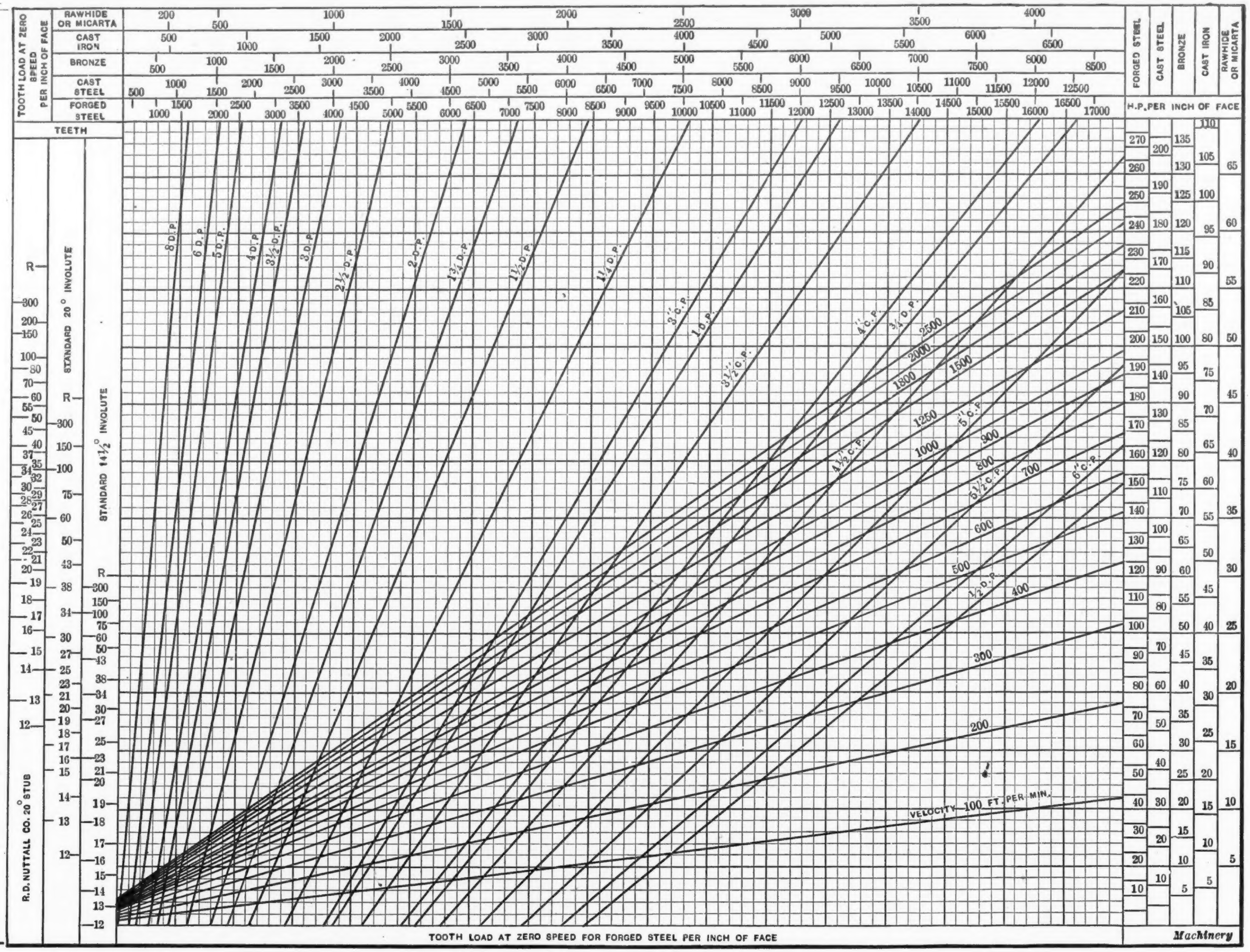


Fig. 1. Chart for determining Power-transmitting Capacities of Gearing and Tooth Loads per Inch of Face Width

Proportions of Industrial Gears*

By G. E. KATZENMEYER, Mechanical Engineer, R. D. Nuttall Co., Pittsburg, Pa.

THE trend of the times is toward more economical and efficient design. A study of the gears in common use discloses wide differences of opinion as to what the engineer considers a suitable design. Evidently if designs can be standardized and a uniform range of sizes adopted, the savings effected in the engineering, pattern, and stock departments and in the shop will be reflected in its costs.

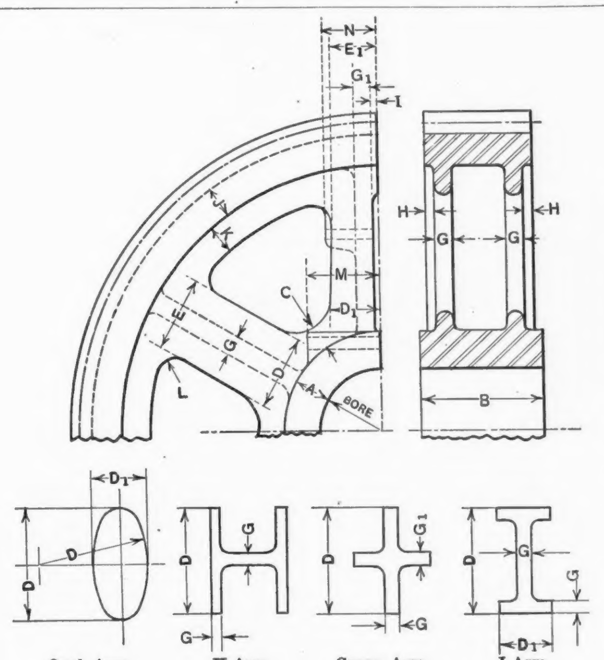
A few years ago it was decided to standardize the design and proportion of industrial gears. Following this decision certain formulas were derived and charts constructed, so that by following a certain procedure, the minimum size of gear for a drive could be readily and conveniently calculated and the sizes thus obtained be inserted on form drawings, without the necessity of making a lay-out on the drawing-board. This was considered desirable when a large number of inquiries were received. When such information as horsepower and revolutions per minute was furnished, it could readily be interpreted and the gear designed, or if the teeth, pitch, and face were specified the design and weight could be determined.

The formulas and charts to be referred to have been developed after a study of various designs and types of gears. What were considered the best proportioned gears were tabulated as to teeth, pitch face, rim thickness, arm sizes and shapes, hub dimensions, etc., and from this information the formulas were derived as a basis for standardization.

In designing a drive to secure the minimum size of gears that can be used, having a sufficient amount of metal under the root of the tooth of the pinion to prevent fatigue and failure, the following method is used: First, calculate the bore diameter of the pinion from the information given, which is generally the horsepower H. P. and revolutions per minute R. The formula used in calculating the bore diameters of pinions and gears is, Bore $= \sqrt[3]{\dfrac{\text{H. P.} \times 80}{R}}$.

This formula is in common use. For general recommendations and for arriving very quickly at an approximate bore, it has proved very satisfactory.

Having thus obtained the size of the bore of the pinion, the next step is to find the minimum pitch diameter which will have enough metal between the keyway and root diameter. To determine the thickness of metal T between the root diameter and keyway, an investigation of a great number of pinions was made, and most of the failures were traced to the inadequate amount of metal above the keyway.



Oval Arm: $D_1 = \dfrac{D}{2}$

H-Arm: $G = \dfrac{3Z}{D^2}$

Cross Arm: $G = \dfrac{6Z}{D^2}$, $G_1 = 0.75G$

I-Arm: $D_1 = \dfrac{D}{2}$, $G = \dfrac{3Z}{D^2}$

$$\text{Bore} = \sqrt[3]{\frac{\text{H. P.} \times 80}{R}}$$

$A = 0.4$ bore or hub diameter $= 1.8$ bore diameter;
$B = 1.25$ bore diameter; (for a gear with a face greater than $1\frac{1}{4}$ bore diameter, make B equal to face; for split gears, make B to suit bolting.)
$C = 0.55A$ or bead diameter $= 2.24 \times$ bore diameter;
$D =$ Dimensions given on chart Fig. 3.
$D_1 = \frac{1}{2}D$ (only for split gears or I and oval arms);
$E = D - \frac{3}{4}$ inch taper per foot;
$E_1 = \frac{1}{2}E$ (only for split gears or oval arms);
$G =$ Dimensions given on chart Fig 3;
$G_1 = \frac{3}{4}G$;
$H = 0.1$ face (only for H or cross-arms);
$I = \frac{1}{4}G$ (only for split gears);

$$\left.\begin{aligned} J &= \frac{\sqrt[3]{0.5 \text{ No. Teeth} \div \text{No. arms}}}{\text{Diam. pitch}} \\ K &= 1.25J \\ L &= \frac{\text{Pitch diam.}}{4.25 \times \text{No. arms}} \end{aligned}\right\} \text{See chart Fig. 4}$$

$M = 2A$;
$N = E_1 + \frac{1}{4}$ inch

MacHinery

Fig. 2. Formulas for determining the Gear Dimensions indicated on the Illustrations

From the information collected the formula,

$$T = \frac{\sqrt{\text{No. Teeth} \div 5}}{\text{Diam. Pitch}}$$

was derived, giving the minimum amount of metal permissible above the keyway.

Having the pitch diameter D_p for a certain diametral pitch P, the number of teeth is readily calculated thus: No. teeth $= D_p \times P$. Having the pitch diameter and the revolutions per minute R, the velocity in feet per minute V is obtained by the formula, $V = 0.262D_p \times R$.

Power-transmitting Capacity

Having the number of teeth, pitch, and velocity, the horsepower per inch of face width is found by the Lewis formula.

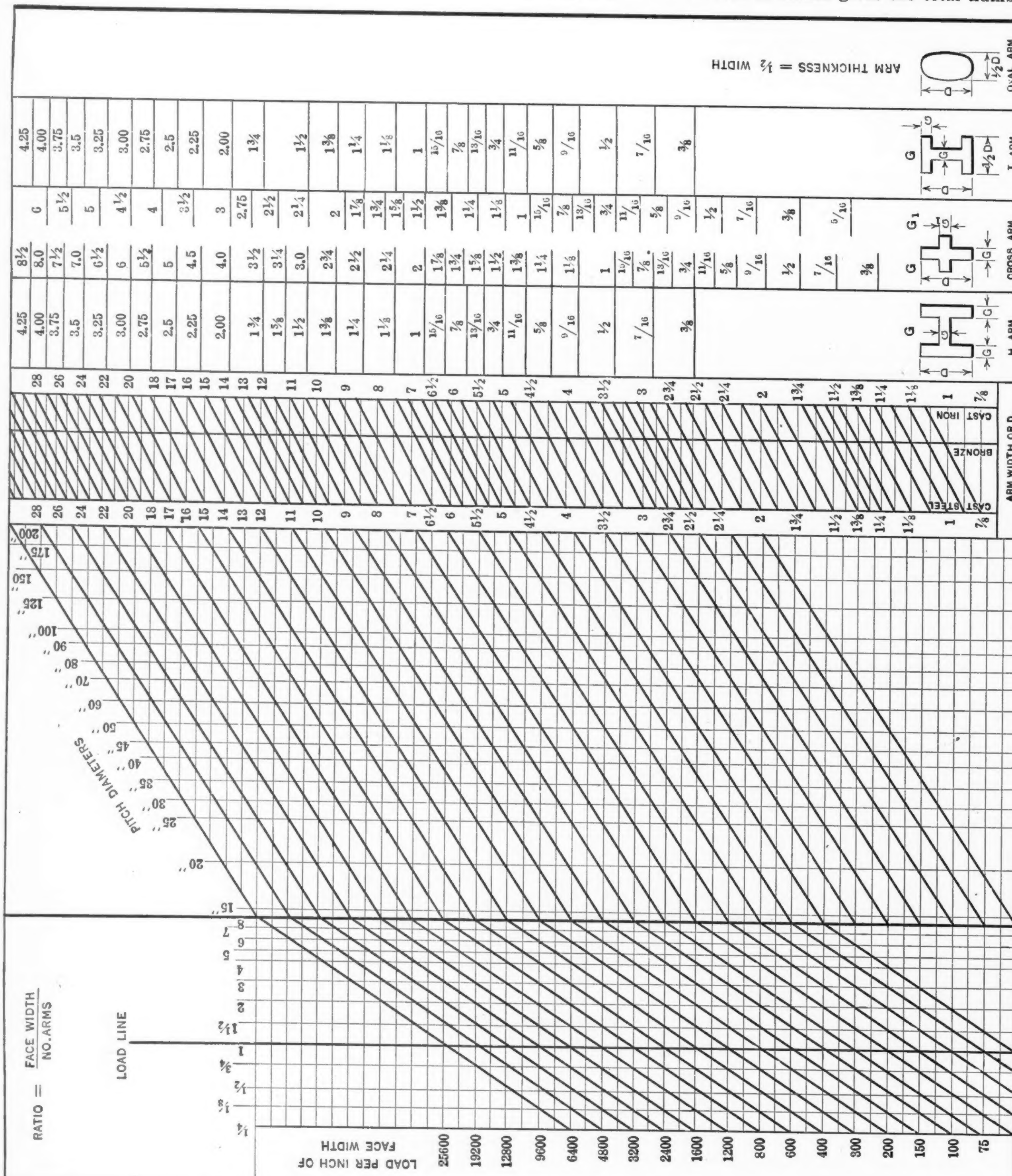
*Abstract of a paper read before the American Gear Manufacturers' Association's convention, April 22.

Then:

$$W = SP_cY \times \frac{600}{600+V} \qquad \text{H. P.} = \frac{W \times V}{33{,}000}$$

where W = tooth load in pounds;
S = fiber stress of material;
P_c = circular pitch;
Y = tooth factor;
H. P. = horsepower; and
V = velocity in feet per minute.

The chart Fig. 1 was constructed from the formulas and is a great help in determining and also in comparing the strengths of different tooth forms and kinds of material. Trace from the tooth column along the abscissa to the pitch line, and then down the ordinate to the velocity line, then along the abscissa to the right and read the horsepower per inch of face width for either forged steel, cast steel, bronze, cast iron, and rawhide or micarta. Multiplying the results obtained by the face width in inches gives the total number



DIRECTIONS FOR USING CHART

After finding tooth load per inch of face width from the chart Fig. 1, trace from the load line of the accompanying chart, up or down the diagonal line to the ratio of face width to number of arms; then along the horizontal line to the ratio line 8; then up the diagonal line to the pitch diameter, and then along the horizontal line to the vertical line for cast steel, which gives the width D of the arm; then trace along the horizontal line to the vertical column representin the style of arm desired (as shown by the diagrams) for other dimensions. If gears are made of bronze or cast iron, trace from the line for cast steel up the diagonal to the line for bronze or cast iron to obtain width of arm; then trace along the horizontal line to the style of arm desired.

Fig. 3. Chart for determining Widths and Thicknesses of Gear Arms for Different Loads per Inch of Face Width

DIRECTIONS FOR USING CHART

To find rim thickness *J*, use the left-hand side of the chart and trace from the number of teeth along the horizontal line to the curve representing the number of arms used; then trace on a vertical line to the diagonal representing the pitch; then trace on a horizontal line to vertical line *J* for rim thickness to root circle.

To find height *K* of stiffening rib, trace from line *J* on a horizontal line to the diagonal extending across the center of the chart; then trace on a vertical line to the top or bottom edge of chart, thus obtaining height of stiffening rib.

To find radius *L*, in inches, between arms and stiffening rib, use right-hand side of chart and trace along vertical line from pitch diameter to diagonal representing number of arms used; then trace along horizontal line to the right to obtain the radius.

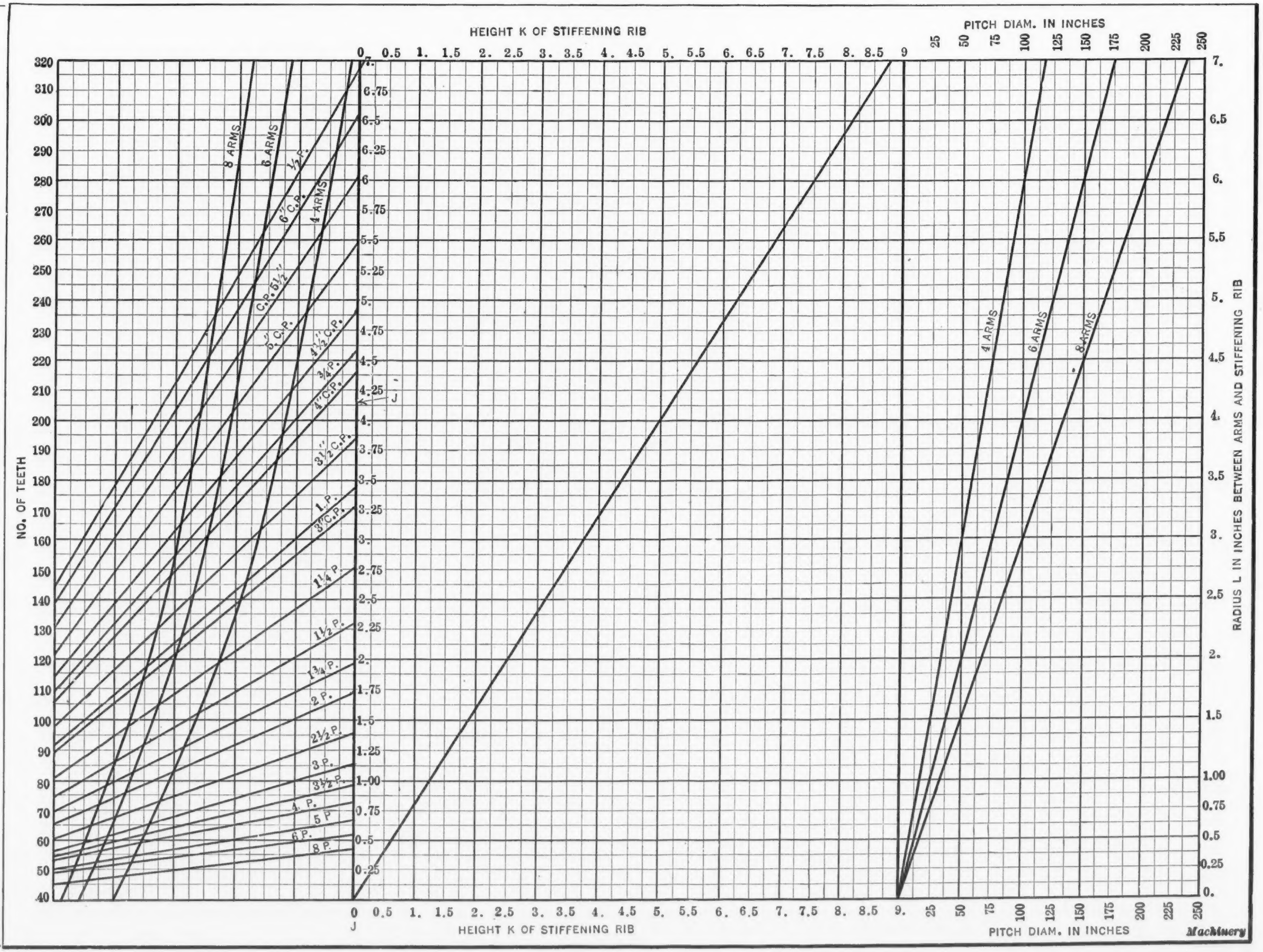


Fig. 4. Chart for determining Rim Thickness J (see Fig. 2) to Root Circle, Height K of Stiffening Rib, and Radius L between Arm and Stiffening Rib

of horsepower. This chart is based on a fiber stress of 20,000 pounds per square inch for forged steel; 15,000 pounds per square inch for cast steel; 10,000 pounds per square inch for bronze; 8000 pounds per square inch for cast iron; and 5000 pounds per square inch for micarta or rawhide.

The face of spur gears is made from three to four times the circular pitch. The minimum face of the helical gears is four times the circular pitch, and the minimum face of herringbone gears is six times the circular pitch. If the velocity factor $\frac{1200}{1200+V}$ is used instead of $\frac{600}{600+V}$ for herringbone or helical gears, the results obtained from the chart can be multiplied by the factor obtained by dividing $\frac{1200}{1200+V}$ by $\frac{600}{600+V}$.

Designing the Gear

After designing the pinion, the gear is designed by using the formulas given in Fig. 2. The bore diameter is determined as previously described in connection with the design of the pinion. Having the bore, the thickness of the hub is made 0.4 times the bore, or the hub diameter is 1.8 times the bore diameter. The hub length is made 1¼ times the bore. If the face is wider than 1¼ times the bore, then the hub length is made equal to the face, except on split gears, the hub length of which is made to suit the bolting, and generally requires a longer hub than a solid gear. The height of bead at the hub is made 0.55 times the hub thickness, or the bead diameter is 2.24 times the bore diameter.

Proportioning the Arms

The next step is the arm design. A six-arm gear is generally used whenever possible in the split and solid type up to approximately 120 inches pitch diameter, and above this size an eight-arm design is recommended. The four-arm design is generally used for split gears under 40 inches pitch diameter with a narrow face and short hub to avoid any special bolting. In calculating the arm sizes, the arm is considered as a cantilever beam with the load equally distributed on each arm. First, calculate for the stalling load or load at "zero speed" which may be found by the formula:

$$\text{Stalling load} = SP_cFY$$

In this formula, F = face width in inches, and the other notation is the same as for the horsepower formula previously given. Having the load, the next step is to find the section modulus of the material, which is,

$$Z = \frac{\text{Stalling load} \times \text{pitch radius}}{\text{No. of arms} \times \text{stress of material}}$$

Having the section modulus, the arm width D (see Fig. 2) is found by the formula

$$D = 2 \times \sqrt[3]{\frac{Z}{0.3927}}$$

This formula is used in calculating the width of all arms and is derived from the formula for an oval section. Let a = ½ width D or the distance from neutral axes to extreme fibers; b = ½ thickness; and $Z = 0.7854\, a^2b$. Then

$$a = \sqrt[3]{\frac{Z}{0.3927}} \quad \text{and} \quad D = 2a \text{ or } 2 \times \sqrt[3]{\frac{Z}{0.3927}}$$

The thickness D_1 of an oval arm is ½ the width D. The thickness of the H-arm section is, $G = \frac{3Z}{D^2}$. The section in this case is considered as a rectangle and the rib joining the two walls is not taken into consideration, as it is intended to give the arm lateral stiffness and not add to the strength in the direction of rotation. The thickness of the cross-arm section is twice that of the H-arm, and the stiffening rib G_1 is made ¾ × G. The width of flange D_1 of the I-arm is made ½ of the arm width, and the thickness of the section is made the same as the H-arm. This arm is used when it is desired to design a gear which will be as light as possible and still be of sufficient strength.

By the use of charts Figs. 1 and 3, the arm sections may be determined readily. On the chart Fig. 1 trace from the teeth along the abscissa to the pitch, then up the ordinate to the load per inch of face for material used. On the chart Fig. 3 use the load obtained from the chart Fig. 1 and trace along the diagonal to the ratio of face width to number of arms, from there along the abscissa to the line marked 8, up the diagonal line to the pitch diameter, then along the abscissa to the material used, and read the arm sizes of the various designs.

The value D_1 = ½D is used with I or oval arms to designate the arm thickness and with split gears as half an arm through the spline at the hub. E is the width of the arms at the rim and is equivalent to D minus ¾ inch taper per foot. E_1 = ½ E and is used with oval arms for the thickness and with split gears as half an arm through the spline at the rim. The H-arms and the stiffening rib of the cross-arm are set back under the rim equal to 0.1 of the face as shown at H, Fig. 2. The amount of relief I from the finished to the rough surface at the spline is made ¼G.

Dimensions of Rim and Stiffening Rib

The thickness of metal J (Fig. 2) between the root of the tooth and rim diameter is equivalent to

$$\frac{\sqrt{0.5 \text{ No. Teeth} \div \text{No. arms}}}{\text{Diam. pitch}}$$

On chart Fig. 4, trace from the number of teeth along the abscissa to the number of arms, then up or down the ordinate to the pitch, then along the abscissa and read the rim thickness. This formula was derived to give varying rim thicknesses, according to the size of the gear and the number of arms used. As a basis, a 100-tooth six-arm gear was considered, having a rim thickness equal to the whole depth of a standard tooth for a given pitch. It will readily be observed that an eight-arm gear with the same teeth, pitch, and face as a six-arm gear does not require the same rim thickness; also that a gear 50 inches in diameter would not require the same rim thickness as a gear 100 inches in diameter, having the same pitch, face, and number of arms.

Height K of the stiffening rib or bead under the rim is made 1¼ times rim thickness J. Referring to the chart Fig. 4, trace from the rim thickness along the abscissa to the diagonal line, then up or down the ordinate and read the thickness of rim bead. Radius L joining the arms and stiffening rib varies according to the pitch diameter and the number of arms, as follows:

$$L = \frac{\text{Pitch diam.}}{4.25 \times \text{No. arms}}$$

From the chart Fig. 4 trace from the pitch diameter up the ordinate to the diagonal representing the number of arms used, then along the abscissa to the right and read the radius.

The height M of the bolt boss at the hub is made equal to $2A$, which is the difference between the hub diameter and the bore. The height N of the bolt boss for the arms is equal to E_1 plus ¼ inch.

When the depth of the keyseat in a hub is checked by measuring across or from the opposite side of the bore, this dimension X may be determined by the formula,

$$X = \sqrt{\left(\frac{Q}{2}\right)^2 - \left(\frac{W}{2}\right)^2} + k + \frac{Q}{2}$$

In this formula

Q = bore diameter;

W = width of keyseat; and

k = depth of keyseat measured at the side.

Although some of the formulas are empirical, the results obtained have been very satisfactory.

Manufacturing Automobile Body Panels

Materials Used in Making Body Panels and Types of Presses Employed

By GEORGE J. MERCER

SHEET steel has come to be used almost entirely during the last twelve years for the panels of automobile bodies wherever quantity production methods are followed. Aluminum is the one other metal used for panels. It is more expensive than steel, but as it is lighter and more ductile, it finds favor where weight is a consideration or where much hand labor is employed in forming the panel. It was these qualities that made aluminum acceptable as the first substitute for wood when automobile bodies made according to carriage practice no longer withstood the severe service to which they were subjected.

Early Use of Sheet Aluminum and Steel

The use of aluminum in the early period increased rapidly throughout the trade, and this demand, together with the needs of other industries, severely taxed the sources from which aluminum was obtained. Consequently, body builders made a practice of ordering their supplies one year in advance, but regardless of this foresight, they frequently had to buy for immediate needs from jobbers who cornered the available supply and charged bonus prices. The unsatisfactory market conditions regarding aluminum compelled the large users to try to find a substitute. A return to wood was not to be thought of and steel was the only other available substitute that could be purchased at a satisfactory price.

Two serious problems faced the pioneer advocates of steel panels: First, there were no large mechanical double-action presses suitable for the work, because similar requirements had never been put up to press builders. Second, with the sheet steel then available it was necessary to heat the metal prior to drawing and forming, in order to prevent it from tearing. Previous work approaching the character of body stampings had been done with dies under a hammer. The metal was also heated in this work, which caused it to scale After such an operation, the scale had to be removed and the part pickled, and much hand labor was involved in finishing and polishing.

The impracticability of continuing under such handicaps resulted in the gradual development of the improved machines and material of the present time. For a short period after power presses were developed for this work, sheet steel was pressed while hot. Present-day accomplishments in any modern stamping plant, such as the cold-drawing

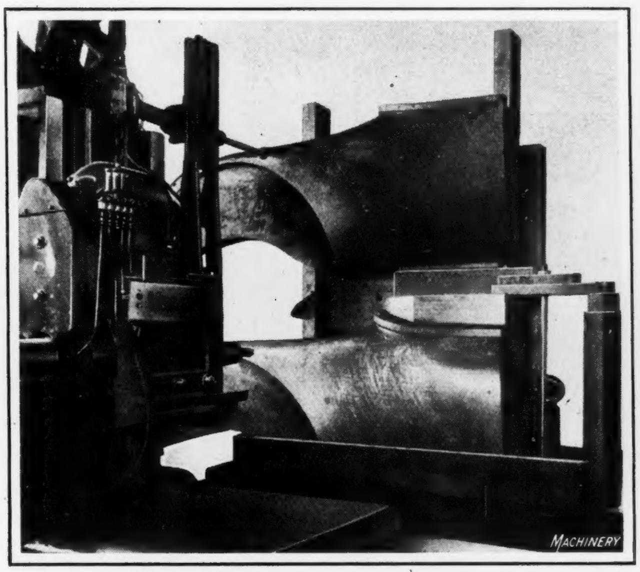


Fig. 1. Machining a Large Die on an Automatic Die-sinking Machine

Fig. 2. Hand Filing a Die after removing it from Die-sinking Machine

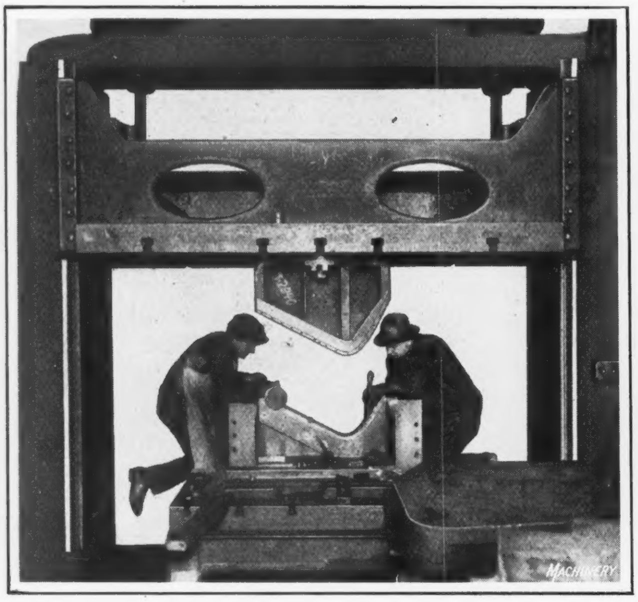


Fig. 3. Matching the Male and Female Die Members of a Set in an Imprinting Machine

Fig. 4. Forming Two Body Pillar Casings together, which are separated in a Subsequent Operation

of wheel housings from No. 22 U. S. standard gage steel to a depth of 6 or 8 inches in a double-action press, would have been incredible.

Quality and Amount of Sheet Steel Used

The steel used is graded according to the character of the work, and is broadly classed as "automobile body stock." It is a basic deep-drawing stock, pickled, annealed, and refined by cold-rolling so that no roughness or pores will develop on the surface in a drawing operation. This last specification is of the greatest importance because any roughness of the steel will show through the paint. Of course, roughness may be removed by hand-filing, but this represents an additional cost which should be avoided, if possible.

The steel most used for panels is No. 22 U. S. standard gage which is approximately 1/32 inch thick and weighs about 1¼ pounds per square foot. Other steels used, but to a limited extent, are Nos. 20 and 18 U. S. standard gage. The amount of steel necessary for a closed body of the sedan type having a wooden frame and steel panels averages 140 pounds. An open body of the phaeton type requires about 100 pounds. The number of pleasure cars that were built in 1921 approximated 1,500,000, and provided two-thirds of this output had phaeton bodies, this would represent a requirement of 50,000 tons of panel stock. The cost of building a sample phaeton body without painting or trimming, averages $400. In quantities of a thousand and over the same body can be produced at a cost ranging from $35 to $70, the metal work in labor and material in each case representing approximately one-third the cost.

The foregoing figures broadly outline the extent of the automobile body industry. The efficiency of its manufacturing methods depends to a large extent on suitable press equipment for drawing, forming, and flanging the metal in a manner that will leave its surface smooth and true. Hand operations in assembling and finishing are thus reduced to the minimum cost. In the following, some of the methods used in body panel manufacture will be described. The accompanying illustrations were obtained at the plants of the Michigan Stamping Co. and the Clayton & Lambert Mfg. Co., the different examples of press work shown being performed on machines manufactured by the E. W. Bliss Company of Brooklyn, N. Y.

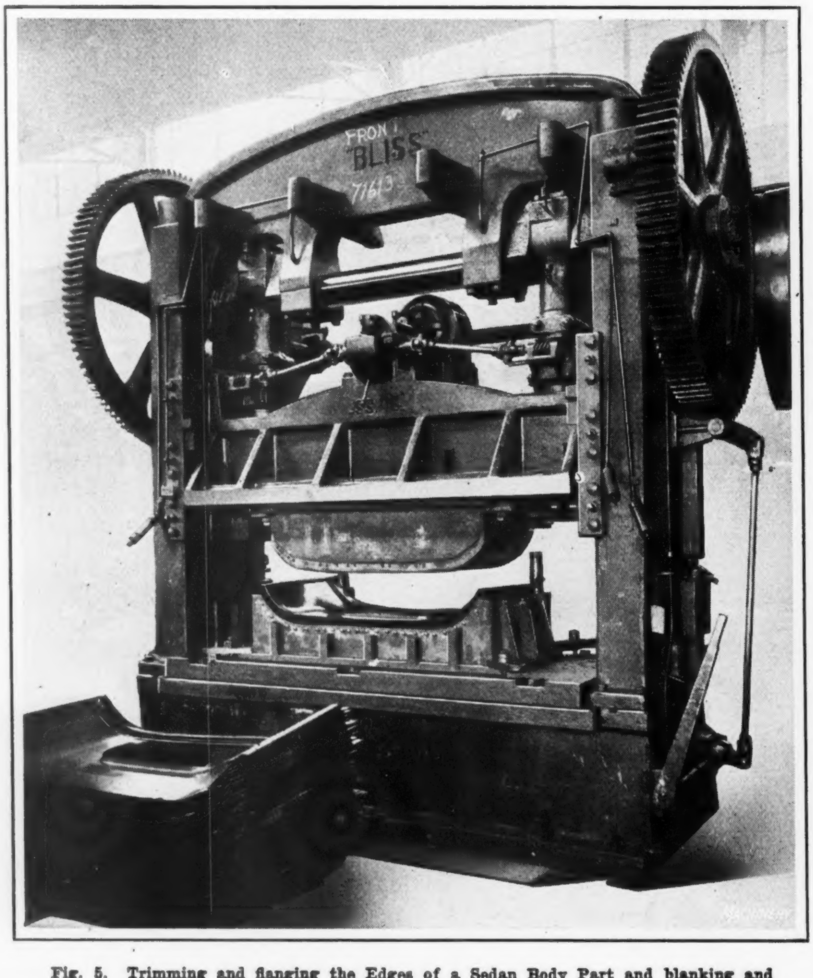


Fig. 5. Trimming and flanging the Edges of a Sedan Body Part and blanking and flanging the Window

The large dies necessary for this work presented a difficult problem at first, as their size and irregular shape made them expensive due to the amount of hand labor involved in making them. The dies are cast, and instead of being filed by hand and ground as formerly, they may now be finished by employing a die-sinking machine. In Fig. 1, a machine built by the Keller Mechanical Engraving Co. is

shown finishing the male die of a roadster rear-side panel. This machine is especially designed for handling large forming, stamping, and forging dies.

A master or model above the work and a small roller which registers on the master are utilized to guide the milling cutter on the work. The master can be made either of wood or plaster. As the tracer is moved over the surface of the master, the cutter is moved correspondingly on the casting, with the result that a die that is a facsimile of the master is produced. The tracer touches the master but lightly, so that the surface does not become defaced. However, the tool is held rigidly at every point no matter how slightly indicated by its guide. This machine is electrically controlled through push-buttons. The work can be moved horizontally and vertically, while the cutter has an adjustment for depth. In some instances a two-thirds saving in die cost has been accomplished by using this equipment.

After the die has been taken from the die-sinking machine, it is hand-filed, as shown in Fig. 2. The final matching of the male and female die members of a pair is performed in the die imprinting machine shown in Fig. 3. This is a machine of recent design which considerably facilitates this work. It affords convenient positions for working on the die, and imprints are easily made. The dies are not taken from this machine until all fitting is completed and they are ready to be set in a press for production. Without such a machine the usual practice has been to hold a press out of production for this work, the imprints being made in the same manner by making a blue mark on one member, then registering the high spots, taking the die out of the press to be filed and finally putting it back for another imprint. Such a method is tedious and laborious, as well as expensive.

The press equipment for making body parts ranges from the large double-crank, double-action toggle drawing press down to the small bench press used in punching nail holes. A typical line of presses of various sizes, all of which are used in panel production, is shown in the heading illustration. The presses used for the major operations are of two types classed as single-action and double-action presses, respectively. Both of these types are of the double-crank style, as often the width of the die bed permits using two dies. Thus blanking and finishing operations can be performed at one downward stroke of the press. In Fig. 7 a large single-action press is shown supplied with two dies, the one at the left being used for blanking and that at the right for flanging.

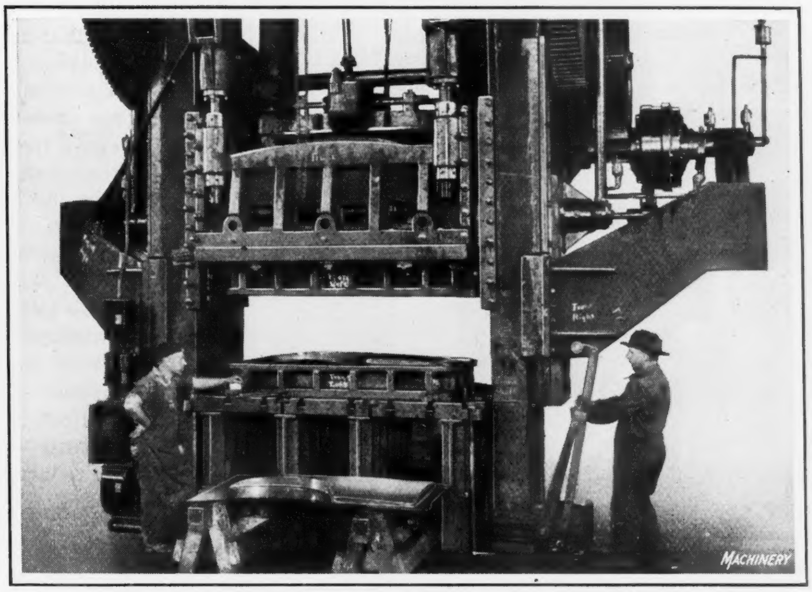


Fig. 6. Toggle Drawing Press with a 9-inch Crankshaft, making Wheel Housings

Single-action presses are used for shallow drawing and forming and for flanging and trimming. They are made in sizes having a crankshaft diameter of from 6 to 10 inches and a die bed usually of from 84 to 124 inches in width, although sometimes the die-bed width is in excess of the latter dimension. When presses of this design are used for forming and drawing, it is necessary to provide additional equipment for holding the metal under pressure. This may consist of spring drawing attachments or pneumatic die cushions. These devices increase the capacity of a single-action press by enabling it to perform, to a limited extent, the same work as a double-action machine. Figs. 4 and 5 show double-crank, single-action presses equipped with spring drawing attachments. The tools in Fig. 5 simultaneously trim and flange the outside of a sedan body part and blank out and flange the window opening. The operation in Fig. 4 consists of forming body pillar casings, two of these being produced from one blank and separated in a subsequent trimming operation.

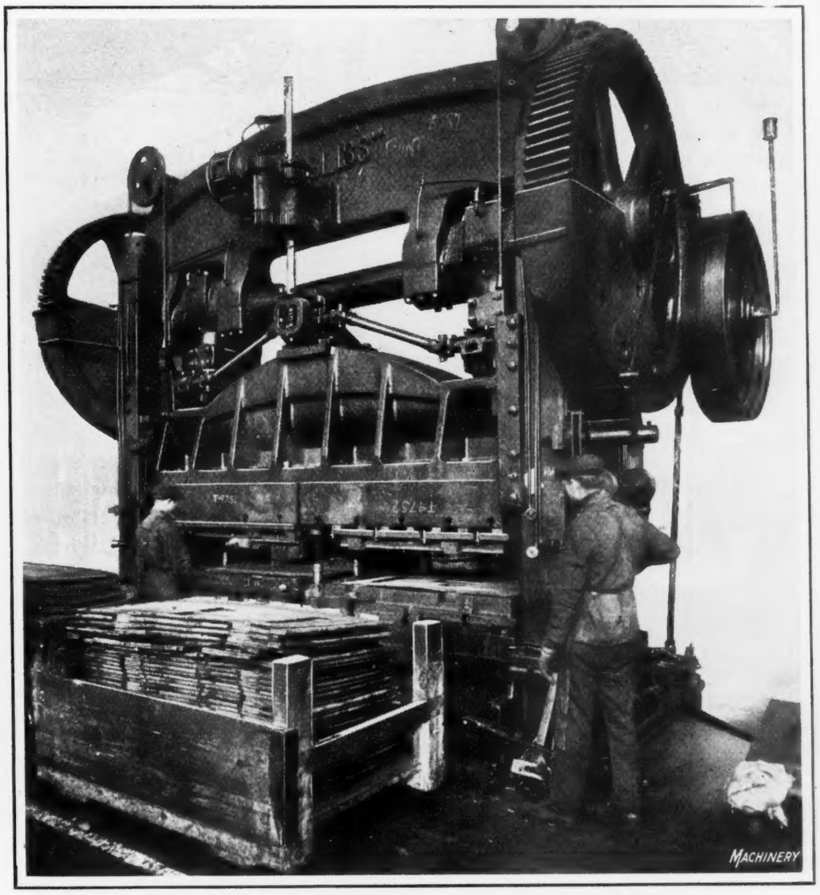


Fig. 7. Large Single-action Double-crank Press used for blanking and flanging a Part at One Stroke

The double-crank, double-action toggle drawing press is used for all the difficult deep-drawing and stretching operations on such work as cowls, wheel housings, mudguards and tonneau backs. Presses of this type are constructed with an inner and outer slide,

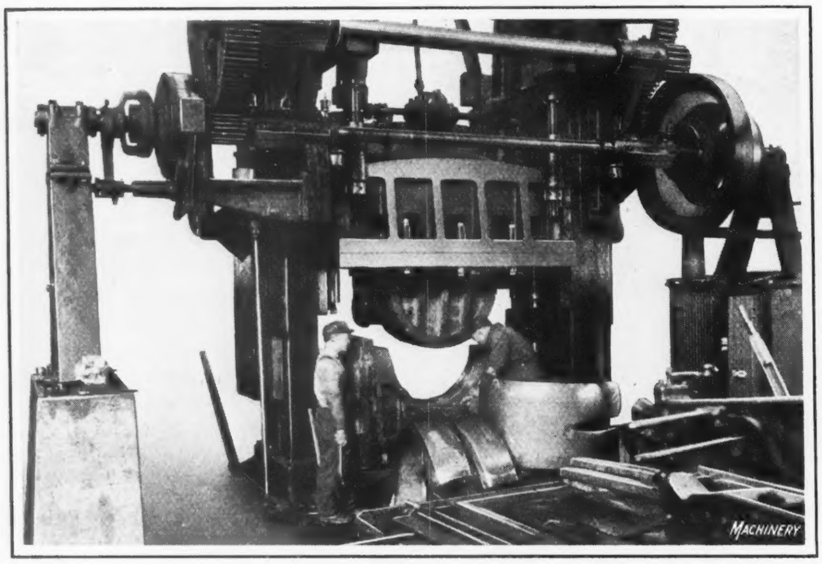


Fig. 8. Another Large-sized Toggle Drawing Press making Mud Guards

and the working tools consist of three members, a lower die, a blank-holder, and a punch. The lower die is fastened to the die bed, the blank-holder to the outer slide, and the punch to the inner or drawing slide. The drawing slide is operated direct from the crankshaft, and therefore has a continuous uniform motion. The blank-holder slide is operated through the toggle mechanism which gives the slide a dwell to hold the sheet-metal blank under sufficient pressure to prevent it from wrinkling or buckling as the punch draws it into the lower die. The amount and distribution of the pressure on the blank means success or failure in deep drawing operations; therefore, blank-holder slides are provided with adjustments so that the pressure may be regulated. The majority of presses of this type have a 9-inch crankshaft which exerts a working pressure of approximately 375 tons. The width of the die bed varies from 86 to 120 inches. There are also some presses with 7- or 8-inch crankshafts, used for door panels, aprons, and other small pieces.

Fig. 6 shows a double-crank toggle drawing press with a 9-inch crankshaft being used to produce wheel housings, and Fig. 8 shows a machine of the same style performing an operation on mud guards. In the latter illustration the operation of pressing a double rear guard has just been completed. Figs. 9 and 10 illustrate two operations on a one-piece cowl. The presses employed are of the same type as those shown in Figs. 6 and 8.

In conclusion, the writer would like to call attention to the warning voiced by those with a varied press experience; that is, when buying a power press, especially if it is to be used for drawing operations, select one with reserve power above the actual requirements. A double-crank toggle drawing press with a 10-inch crankshaft is more economical in the long run for doing the work that a 9-inch crankshaft machine is normally intended for, than a press of the latter size would be. The reserve power of the 10-inch press will give an additional factor of safety and avoid mishaps and breakdowns. A press is subjected to unusual stresses, and the larger machine, having an excess of strength, will not be injured by the overload and consequently will always be ready for continuous production.

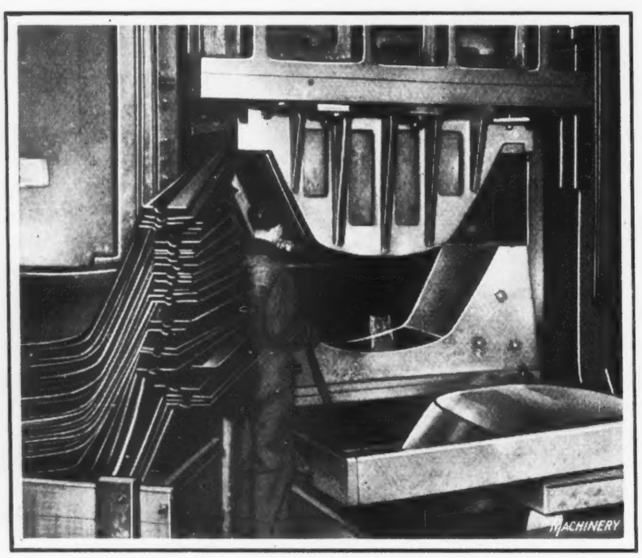


Fig. 9. Close-up View of an Operation on a One-piece Cowl

* * *

The London & Northwestern Railway in England has arranged to make trial runs of a condensing-turbine electric locomotive, which has recently been completed by W. G. Armstrong Whitworth & Co. Ltd., at Scotswood. The locomotive is made up of two engines, the leader being a 2-8-0 type and the trailer 0-8-2. The engines are equipped with four 275-horse-power, three-phase slip-ring motors. Two of the motors drive the leading engine, which also carries the boiler and the impulse-pressure compounded multi-stage turbine and generator. The other two motors drive the rear engine, which carries the condenser, cooling water, and coal. Each engine has eight coupled 4-foot driving wheels, and the total weight is 130 tons.

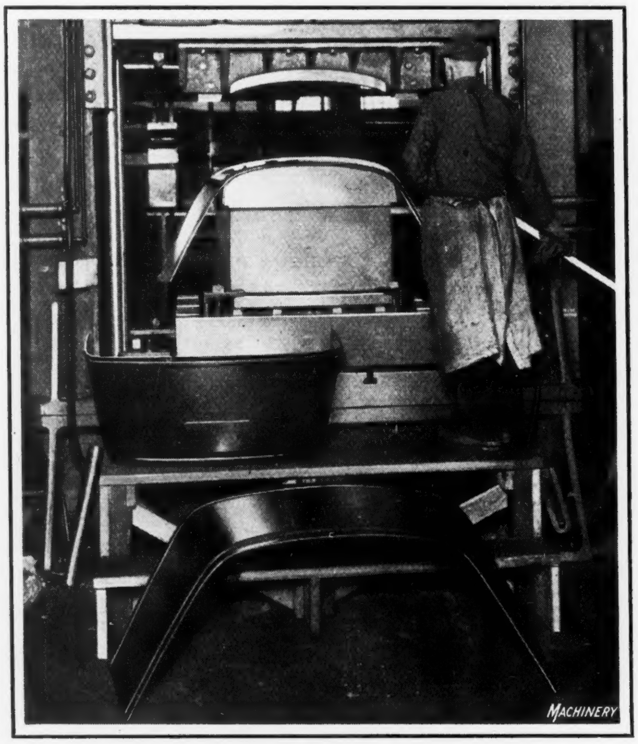


Fig. 10. Another View of an Operation on a Cowl

* * *

According to the 1919 census of manufactures, there were in that year 4000 factories, with 400,000 employes, engaged in building industrial machinery of all kinds, the production representing $2,200,000,000. Even under the depressed conditions in 1921, the exports of machinery for industrial purposes of all kinds were valued at $254,000,000. Industrial machinery does not include such items as typewriters, sewing machines, etc., not mainly intended for industrial purposes.

Cost Recording and Production Control in Drop-forging Plants

By H. F. OSLER

A system of management that has proved very successful in two large drop-forging plants is described in the following. Before proceeding with a description of the system, a brief analysis will be made of certain conditions in the drop-forging industry that demand the general adoption of more efficient cost-recording systems.

Demand for Accurate Cost Records

Manufacturers in all industries realize now, as never before, the vital importance of a reliable cost-recording system. The conditions of present-day competition are such that contracts must be made at small margins of profit. For this reason, actual production costs must be known and intelligently employed in planning future production and setting contract prices. Unquestionably, a cost accounting or recording system cannot function satisfactorily unless it is closely coordinated with the planning and production control system. The establishment of such a system in a drop-forging plant, however, presents a very difficult problem.

Effect of Inefficient Cost System

In many instances, the manufacturer who cuts his price does so because he does not know his actual production costs, but relies on the ability of his plant to turn out the work at as low a cost as the plant of his competitor can. This practice often results in a contract that cannot be carried out at a profit, and, in many instances, results in an actual loss to the manufacturer. In the attempt to fill such orders or contracts at a profit, quality is often sacrificed. Thus it becomes evident that the manufacturer whose business is conducted on a basis of accurately computed costs has the advantage over his competitor, who can only estimate the approximate manufacturing cost of his products.

Many manufacturers of drop-forgings claim that it is practically impossible to lay out a work schedule in their plants that can be adhered to or successfully followed, and that the processes of manufacturing are such that accurate production costs cannot be ascertained. For this reason, those engaged in the management of drop-forging plants will find the following description of a successful production control system in a drop-forging plant of timely interest. The system to be described owes much of its success to the close coordination that it tends to establish between the production planning, production control, and cost-recording departments or units of a plant.

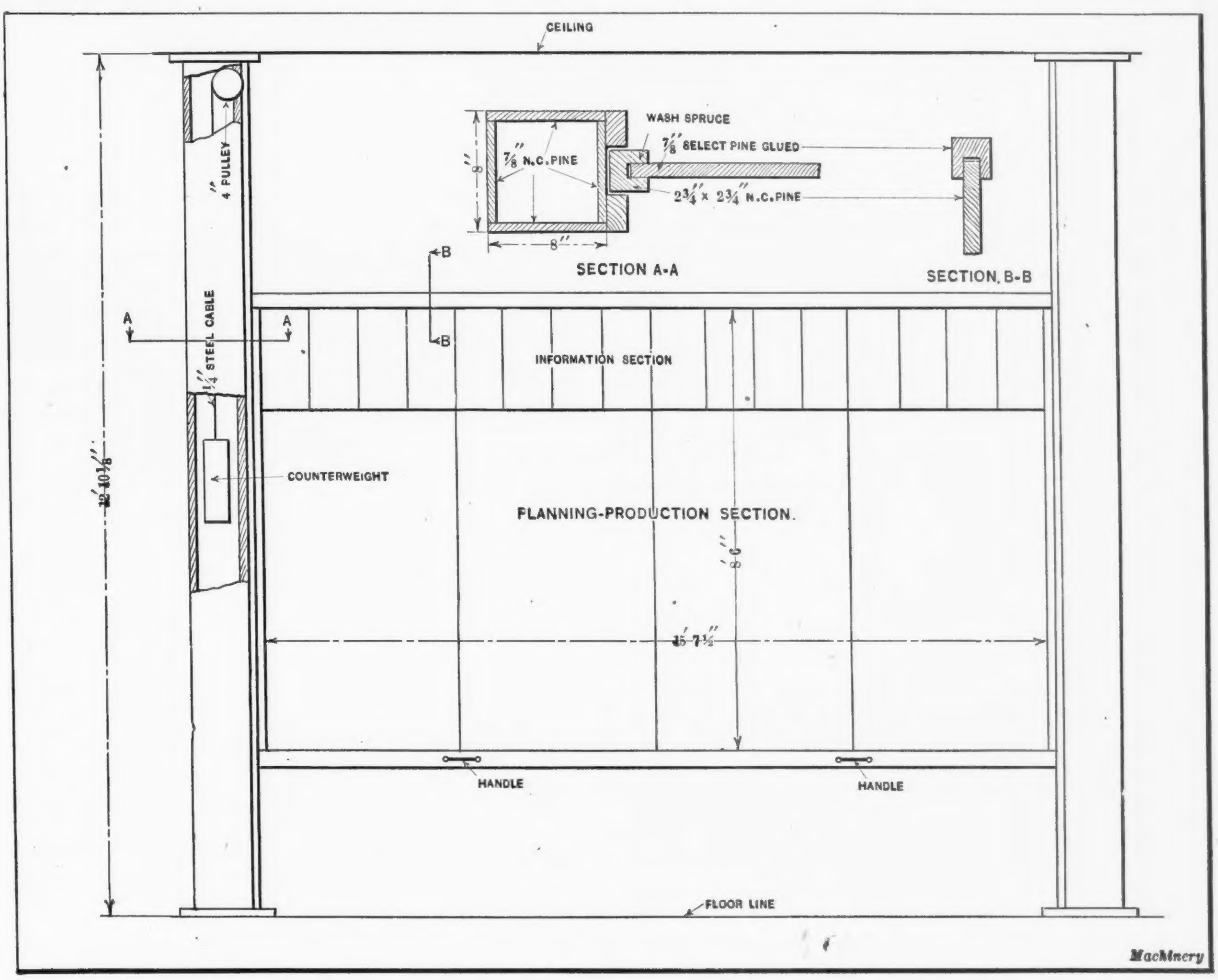


Fig. 1. Information, Planning, and Production Control Board used in the Planning and Production System of a Drop-forging Plant

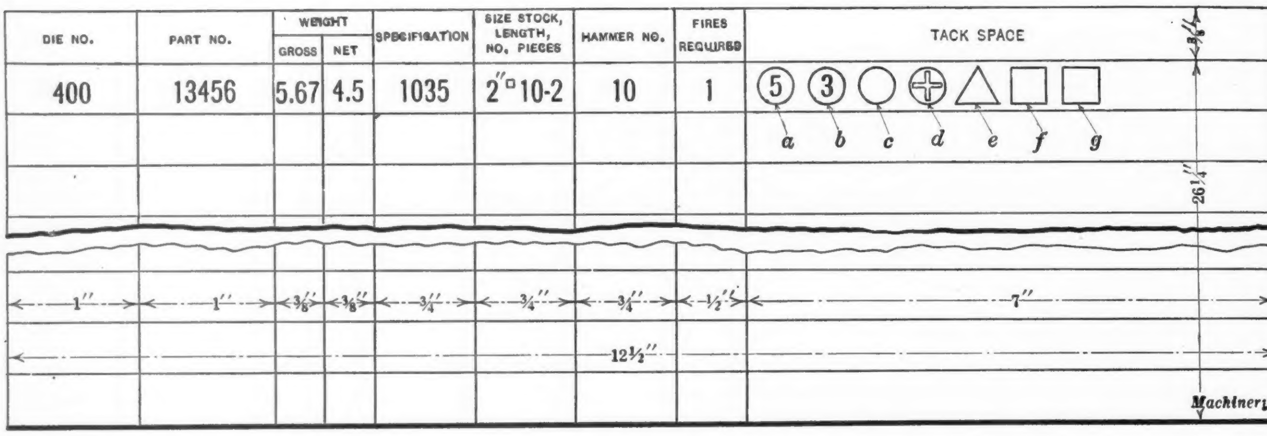


Fig. 2. Information Recording Sheet employed on the Control Board shown in Fig. 1

Production Control System

A simple method of showing graphically the production plans for three months in advance, the existing state of work under way, and the complete history of finished work, forms the basic principle on which the system to be described was developed. One of the most important features of the system is that the collection of data showing the actual cost of each and every individual product is accomplished almost automatically. The system is so carefully worked out in this respect that costs are known at once—not days or weeks after the work is completed.

The Planning and Production Board

The combination information, planning, and production board shown in Fig. 1 forms the backbone of the management system. On the upper section of the board designated "Information Section" are placed the information sheets, one of which is shown in Fig. 2. A board of the dimensions shown in Fig. 1 will accommodate a sufficient number of these sheets for recording the production progress of 100 dies. The lower section of the board carries the planning and production sheets. A section of one of these sheets is shown in Fig. 3. The capacity of this section of the board is sufficient to provide for the production records of the current month and the plans for two succeeding months. When the current period ends, the record sheet is removed and succeeded by the next sheet, and a new one is placed on the board so that the board will carry the plans for practically three months in advance. Thus the progress of work under way and the plans for from two to three months in advance can be seen at a glance.

Information Section

On the permanent information sheet shown in Fig. 2 is placed each die number in its numerical order, and opposite the die number in the second column is placed the number of the part which the die produces. In the illustration, 400 is the number of the die and 13456 the number of the part produced by the die. In succeeding columns are given the gross and net weight of each forging made by the die, the size of material to be used in making the forgings, the length to which the material is cut, the number of pieces each length will make, the number of the forging steel specifications, the hammer for which the die is best suited, and the number of fires and helpers required to make the forgings. Following these columns a space is reserved in which to insert tacks which are used to indicate by their shape, color, or color combinations, all the information required to insure the proper execution of orders for having the stock and dies delivered at the proper place at the right time.

The key or explanation to the tack system of recording information is given in the form of a chart located near the planning board. For instance, the tack at *c* has a round red head, which, according to the chart, would indicate that an order for forgings for part No. 13456 has been received. The tack at *a* has the highest serial number used in connection with this part marked on its head, and the tack at *b*, the serial number then in use or the one last used. Two of these plain tacks on which numbers can be written are required for each die, and they are the only ones that ever bear any written notes or numbers. All the other kinds of tacks employed—forty-three in number—convey the desired information simply by their shape, color, or color combinations.

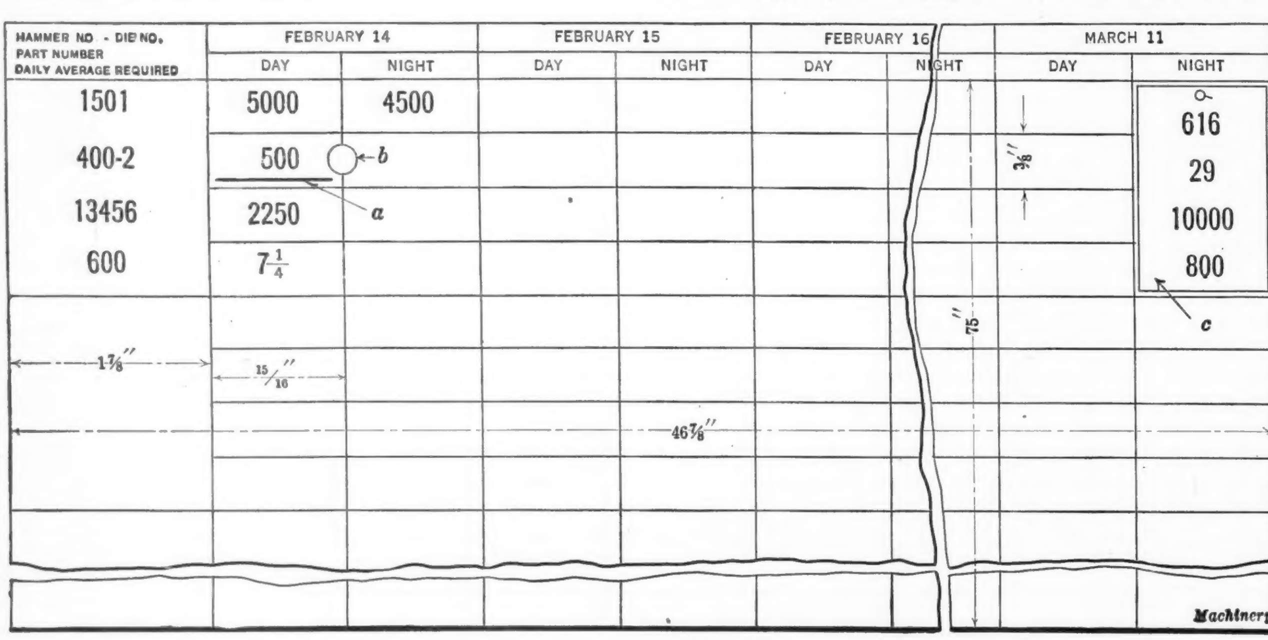


Fig. 3. Production Recording Sheet used on Control Board of a Drop-forging Plant

That is, some of the tacks for a certain class of information will be round and of a solid color, while others may have crosses or bars of a different color.

Still other tacks such as those used for recording information regarding dies or forging trimmers may be square or triangular in shape. Information which must be recorded in connection with all orders is represented by tacks of the more common colors. Considerable attention has been given to the selection of the colors and shapes for the tack heads in order to make the system as easily understood as possible.

Round-headed tacks have the following meanings: When solid red color, orders for forgings; blue, ship freight; pink, ship express; slate, ready to ship; heliotrope, orders held up by customer; black with white cross, steel available; black with white T, steel shipped; black with white horizontal bar, steel ordered; turquoise, hot trim; lavender, cold trim; orange, to be hot restruck; black, to be cold restruck; (square instead of round) slate, to be squeezed; (round) white, to be ground; green, to be pickled; brown, to be tumbled; yellow, to be heat-treated. Square-headed tacks have the following meanings: blue, dies being sunk; yellow, dies to be resunk; brown, dies to be repaired; orange, dies being repaired; green, dies ready for production; white, lead away for approval; red, lead approved.

Triangular-headed tacks have the following meanings: blue, trimmers being made; yellow, trimmers to be made; orange, trimmers being repaired; brown, trimmers to be repaired; green, trimmers ready for production; slate, trimmers scheduled; black square-headed tack, dies scheduled. Round tacks with a dot at center have the following meanings: Red, restriking hot; blue, restriking cold; white, squeezing; green, grinding; brown, pickling; black, tumbling; yellow, heat-treating; orange, forging; turquoise, trimming hot; lavender, trimming cold.

While a large variety of tacks seem to be required, the individual meaning of each can be memorized in a surprisingly short time. Ordinarily, it is necessary to use only a comparatively small number of the different kinds in order to record all the desired information, as the work generally follows a regular course. The presence of a tack in a board of a kind not commonly used immediately calls attention to some break in the usual procedure, and therefore holds the executives attention until the work is again progressing along normal lines.

The hammer numbers are placed in their numerical order on the production sheet shown in Fig. 3. Directly under the hammer number is placed the number of the die which is to be employed at the beginning of the period. Under the die number is placed the symbol or part number and the number of forgings that constitutes a day's work. At the top of the next column is placed the number of forgings required. At the close of each shift, the production department places under this quantity the number of forgings made during that shift. The difference between the number made and the number required is then placed at the head of the next column. This method of recording is continued until the order is completed.

Under the number of forgings made, is placed their total net weight, and under this the hours actually spent in making the forgings. Under the number representing the day's production is drawn a line, such as indicated at *a*, which shows by its color the reason for the delay in production. For instance, a red line signifies that a delay was caused by hammer trouble; a white line, that a delay was caused by absence of the operator; a blue line, die or trimmer troubles; a yellow line, trouble with steel; a black line, power troubles; and a green line, furnace troubles. After the day's production, is inserted a tack *b* which indicates by its color the progress made. For instance, a red tack indicates that production is behind schedule for that particular shift; blue, that production is up to schedule time; yellow, that production is ahead of schedule; black, that production schedule cannot be met.

Opposite each hammer number and under the date on which a new die is to be placed in the hammer, is pinned a ticket *c*, giving the die number, part number or symbol, quantity of forgings to be made, and number of forgings constituting a day's work. This method of recording production plans is carried out for three succeeding months, that is, a new sheet is put up at the end of each month when the sheet carrying the records of the current month is taken down.

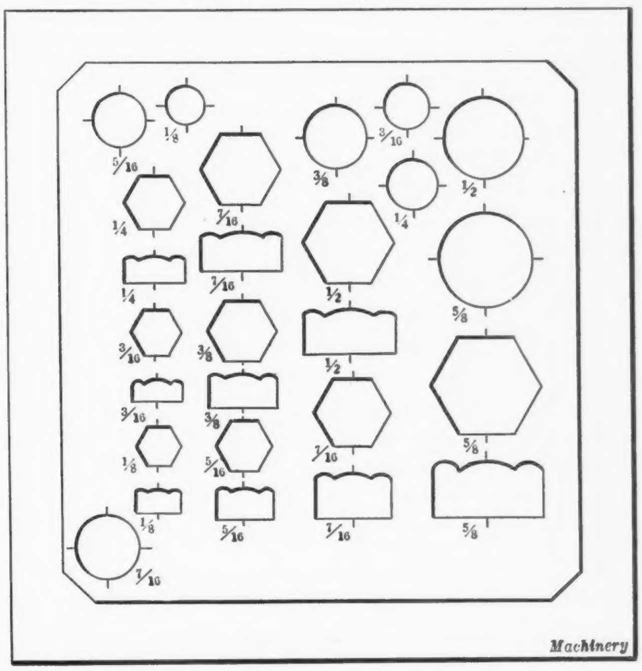
This concludes the first installment of this article; the second installment which will appear in July MACHINERY, will describe the actual operation of the system outlined in the foregoing.

* * *

DRAFTING TEMPLET

By G. EDWARD PORTER

The writer read with interest the description of the Lopez "Draftsquare" on page 331 of December, 1921, MACHINERY. In the accompanying illustration is shown a similar device. About seven years ago the writer made up twenty-four of these templets from celluloid 0.015 inch thick. While the templet described in December MACHINERY and the one here shown are obviously intended for the same purpose, it will be noted that their arrangement is somewhat different. One of the twenty-four templets referred to is still used by the writer and is in as good condition as when new. In using the templet, it is understood, of course, that regular center



Templet for drawing Nuts and Circles

lines must be drawn in order to provide a means of locating the device.

In drawing the plan view of the head of a 1/2-inch nut the circular opening in the templet designated as 1/2 is centered over the intersecting center lines on the drawing by means of the four lines equally spaced about the opening. The opening is then used as a guide for tracing a circle which will have a diameter equal to the dimension across flats of a 1/2-inch nut. The templet is next slid over the drawing until the hexagonal opening designated as 1/2 is in such a position that its six sides are tangent to the circle. With the templet in this position, the outline of the nut can be readily drawn by using the hexagonal opening as a guide for the pencil. In order to facilitate the drawing of threads, the writer cut suitable notches into the edge of the opening in a 30–60 degree triangle. Before cutting the notches, care was taken to make the edge of the opening parallel with the outside edge.

Making Radio Parts

By FRED R. DANIELS

Typical Examples of Screw Machine and Press Operations Employed in the Manufacture of Wireless Equipment

THE methods used in the manufacture of radio apparatus are quite simple, and reveal no startling developments; but the manufacture of radio instruments has grown so rapidly that it has assumed the proportions of an independent industry. For this reason a description of the more important phases of the shop work in this field will prove of interest. This article deals with screw machine and press work in radio shops, the examples having been selected from the practice of well-known manufacturers in the radio field. They are typical of the class of work required to produce wireless receiving sets. Before describing the manufacturing methods, it will be well to mention the parts used in radio receiving sets. Satisfactory sets of this type, using single-circuit equipment, require six units as follows:

1. The antenna or aerial which absorbs the radio waves in the atmosphere and delivers the electrical pulsations to the receiving instruments of the radio equipment.

2. The inductance or tuning coil which is the means of adjusting the wave length of the receiving apparatus to correspond with that of the transmitting station. This unit may be in the form of a plain tubular winding *A*, Fig. 1, or it may be made with a special winding known as a "honeycomb coil," as shown at *B*.

3. The detector which may be either a suitably mounted galena (lead sulphide) crystal *C*, or for higher efficiency, a vacuum tube *D*. The detector changes current from radio frequency—100,000 or more pulsations per second—to frequencies which can be transformed into sound waves.

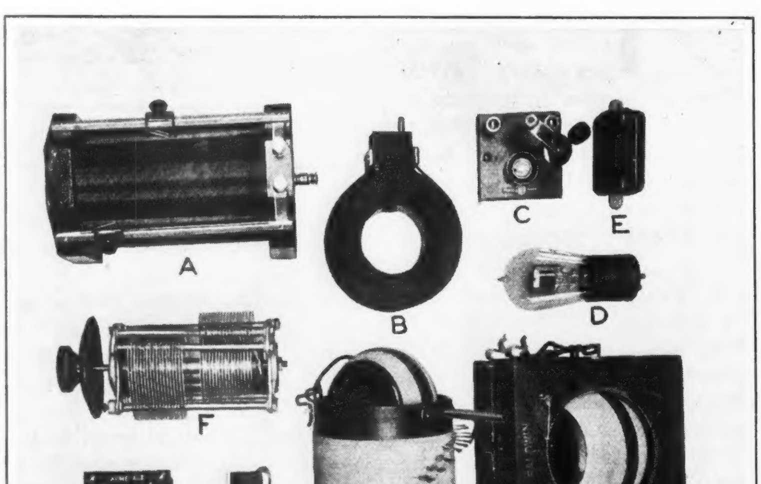


Fig. 1. (A) "Ideal" Tuning Coil; (B) DeForest Honeycomb Coil; (C) Andrea Crystal Detector; (D) Radio Corporation Vacuum Tube; (E) Spitdorf Fixed Condenser; (F) Clapp-Eastham Variable Condenser; (G) and (H) Baldwin Vario-coupler and Variometer; (J) Acme Amplifying Transformer; (K) Radio Corporation Rheostat

4. The condenser which is used in conjunction with the inductance or tuning coil to obtain a finer adjustment of the incoming radio waves than is possible with the tuning coil alone. A fixed-capacity condenser is shown at *E* and one of variable capacity at *F*.

5. The head telephone receiver which transforms the pulsating current into sound waves; these are of the familiar construction common to wire telephony.

6. The ground connection.

Each receiving set is designed for a certain wave-length range and will handle only signals sent out by a particular type of transmitting apparatus. Electromagnetic waves are produced either by means of a spark, an arc, or an oscillating vacuum tube. All three are used for radio telegraphy, the first sending out damped waves, the second, damped or undamped waves and the third undamped or continuous waves (C.W.). For telephony or broadcasting, the oscillating tube is generally used, but the continuous wave must be "modulated" for the transmission of speech. Consequently, most single-circuit sets are designed to receive speech tones sent out by a modulated continuous wave (M.C.W.) transmitter.

The units of non-regenerative or single-circuit receiving sets, previously described, differ from those used in the regenerative circuit sets. The latter are capable of receiving all kinds of radio communication, whereas the non-regenerative set is capable of receiving only modulated continuous wave (M.C.W.) and the damped wave telegraphic signals. In

the case of the regenerative circuit, the inductance or tuning coil is variably connected by a device, shown at G, Fig. 1, which is known as a vario-coupler. The vario-coupler is used for tuning and is connected in circuit with a variometer H. The variometer contains a rotor having suitable exterior windings, rotating within the stator which has interior windings and which partially encloses the rotor. The vario-coupler and the variometer together perform the same function in the regenerative type of receiving set that the tuning coils A or B and the condensers E or F do in a non-regenerative or single-circuit receiving set. One of the most valuable means for adjusting and controlling the current is the rheostat, which in most types of instruments is of similar design to that illustrated at K.

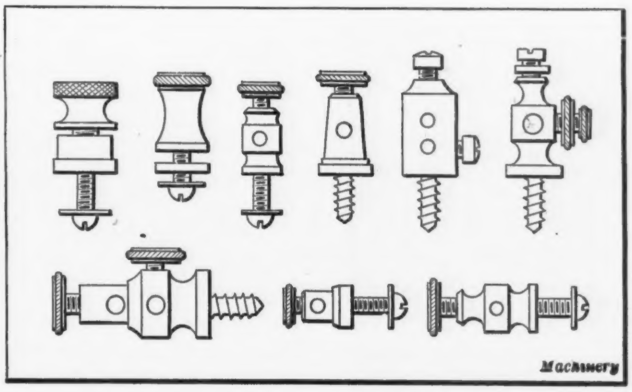


Fig. 2. Various Designs of Brass Binding Posts

In addition to the units necessary for merely receiving wireless messages, it is also highly desirable to include a device for amplifying speech, especially if the transmitting station is so far away that the tones are faint. Almost all commercial tube-detector sets, and even some crystal detector sets, have provision for attaching an amplifier. The amplifier consists of one or more amplifying transformers J, connected to the detector circuit and to an amplifying vacuum tube, and a "loud speaker," which is a horn containing a telephone receiver. One amplifier is used to produce what is known as "one-stage amplification"; if a greater volume of sound is required, two or more stages of amplification may be employed.

The vacuum tube forms the most important part of all radio transmitting and receiving sets, except those that operate with a crystal detector. The tube is a glass bulb in which three units are contained—the filament, the grid, which is a coil or mesh of wire surrounding the filament, and the plate which surrounds the grid. This part is clearly shown at D.

The collection of radio parts that are illustrated in Fig. 1 was photographed for MACHINERY by the Manhattan Electrical Supply Co., of New York City.

Screw Machine Work in Radio Manufacture

There is a great variety of small screws, washers, contact points, terminal fastenings, binding posts, etc., used in radio instruments. Most of these parts are made of brass and are typical automatic screw machine products. In Fig. 2 are shown a few of the many designs of binding posts —one of the most common screw machine products used in wireless instruments. Another class of screw machine product that is extensively used may be termed "inserts"; these are fastenings, sockets, threaded parts, etc., molded into insulating material such as condensite, bakelite, or formica. The molding of these materials will be dealt with in a separate article, and special attention will be given to the molding of parts containing metal inserts. In the plant of the DeForest Radio Telephone & Telegraph Co., the automatic screw machine work is done on a battery of No. 52 National Acme screw machines, while the Adams-Morgan Co. employs No. 0 Brown & Sharpe automatics.

The variable air condenser, shown in section in Fig. 3, is representative of the classes of machine work found in radio construction. This is a DeForest instrument which consists of a number of hard aluminum plates A, assembled in a fixed position, and a number of similar plates B, assembled together with provision for turning them to vary their position relative to the fixed plates. The plates may be mounted on the spindle C by means of suitable spacing washers, or they may be molded in a lead core on the spindle. These movable plates are operated by a bakelite knob D fastened to the spindle. For convenience in making adjustments a graduated bakelite dial E is employed. The unit contains numerous examples of screw machine work, such as spacing washers, screws, binding posts, and supporting posts for the two end plates. It also contains good examples of press work, as well as of molded insulator work.

In the manufacture of radio apparatus, use is also made of the hand screw machine or small turret lathe. One example of this class of work is found in the manufacture of vacuum tube sockets in the Adams-Morgan Co. shop. The

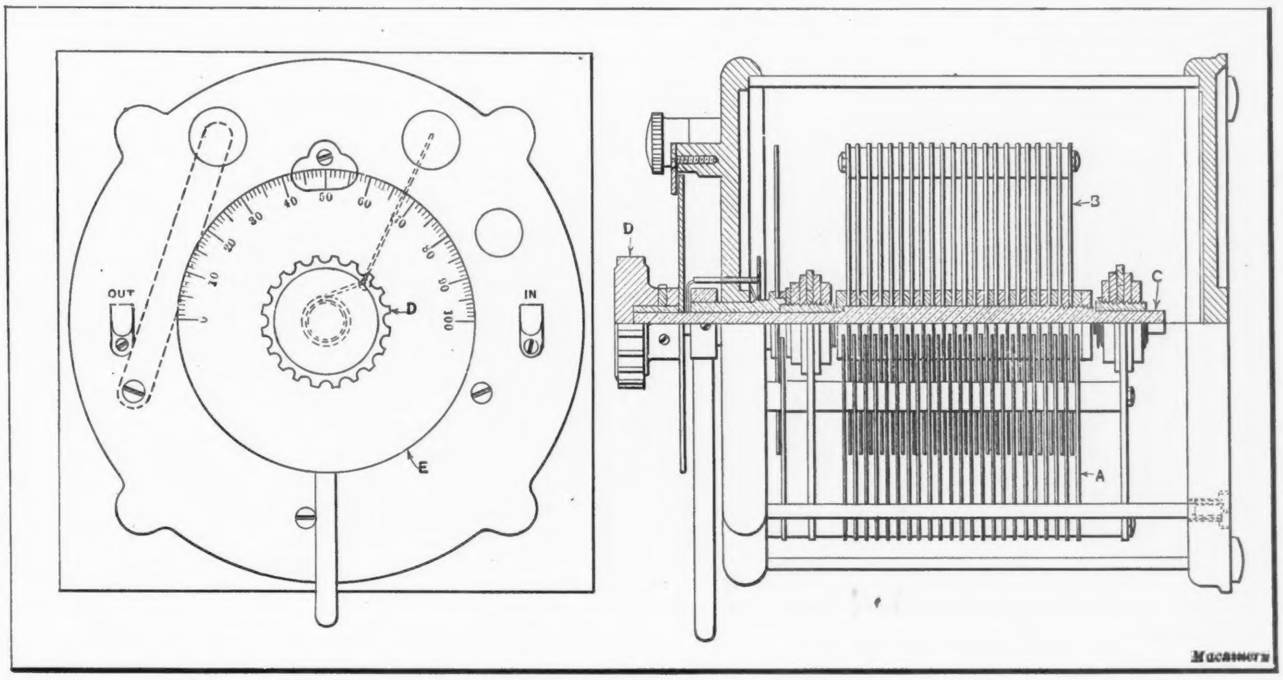


Fig. 3. Variable Vernier Air Condenser used in Radio Receiving Apparatus

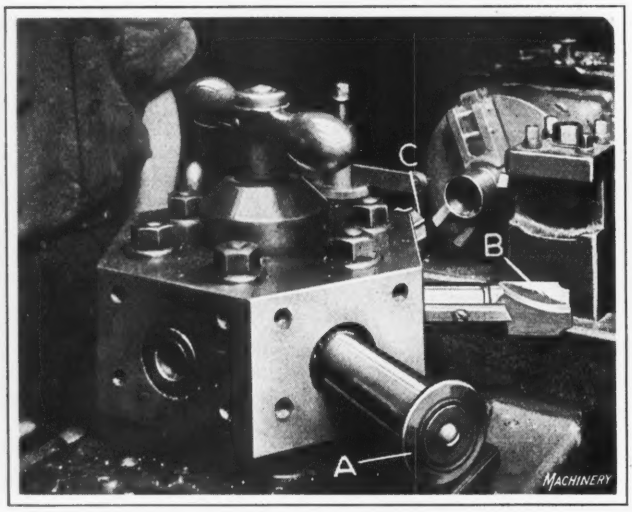


Fig. 4. Turret Lathe used in making Sockets for Vacuum Tubes

sockets are made from 1½-inch brass tubing on a Foster turret lathe, tooled as shown in Fig. 4. The sockets are subsequently molded into a bakelite base, and to help anchor them in the base they are knurled at one end. The operations are: (1) knurling; (2) rough-reaming and forming the end; (3) reaming to size; and (4) cutting off.

The knurling rolls are carried in the front toolpost and the cutting-off tool in the rear tool-holder. The tube is chucked by a three-jaw Union chuck, and the brass collar *A* serves as a stop. For rough-reaming the sockets and forming the end, a special tool *B* is used, to the side of which an auxiliary tool is attached for rounding the end of the tube. A rose reamer *C* is used in the third operation to size the sockets. It may be of interest to add at this time that tube sockets are not always made from brass tubing. The DeForest sockets are molded from bakelite and require no machine work to finish them.

Power Press Work

The tube sockets are molded into a bakelite base, and when returned from the molder they must be polished, plated, and buffed. A bayonet slot, by means of which the vacuum tube is locked in place, is finally punched on a foot-press; this operation is illustrated in Fig. 5. The bakelite base contains molded slots and these are used to locate the bayonet slot properly. The sockets are slipped over a mandrel, and a square-section latch which is hinged to the lower die is swung into engagement with one of the slots

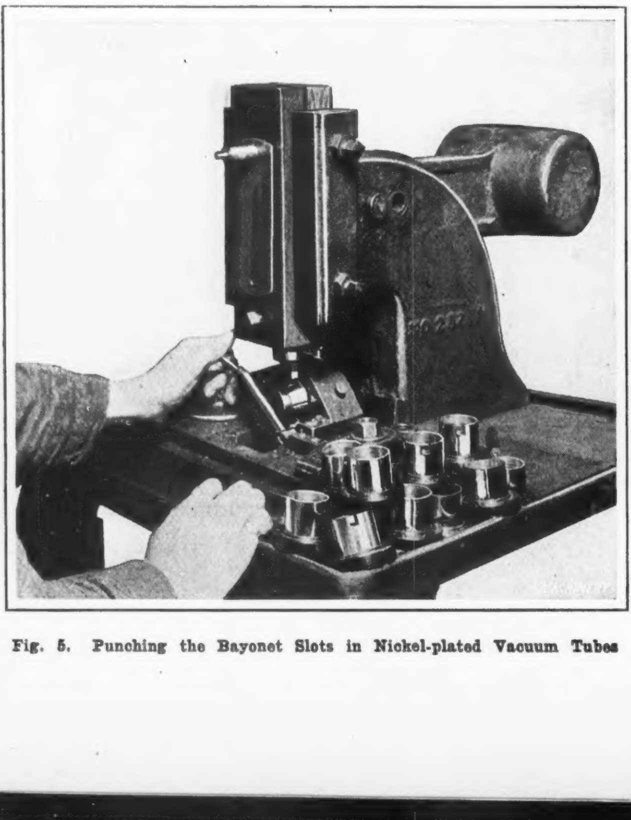


Fig. 5. Punching the Bayonet Slots in Nickel-plated Vacuum Tubes

in the molded base to position and hold the work. The punch, of course, is of the proper shape to produce the L-shaped slot. The thickness of the wall section is 0.065 inch.

Reference previously has been made to Fig. 3 and attention directed to the press work entering into the construction of the variable condenser. The aluminum plates are punched out in dies of similar construction to those illustrated in Fig. 6. The operation illustrated is the punching of the brass end plates for the condenser, the work being performed in the DeForest plant on a V & O press. These end plates are made of sheet brass, 3/32 inch thick, and are punched from strips of sufficient width to permit the stock to be reversed, so that two rows of stampings can be produced from the strip, thus reducing the scrap to a minimum.

Another simple power press operation is involved in making contact points for DeForest inductance coil mountings. One of these mountings, a "honeycomb" coil, and a diagrammatic sketch of the stock from which contact points are punched, are shown in Fig. 7. The mounting is designed

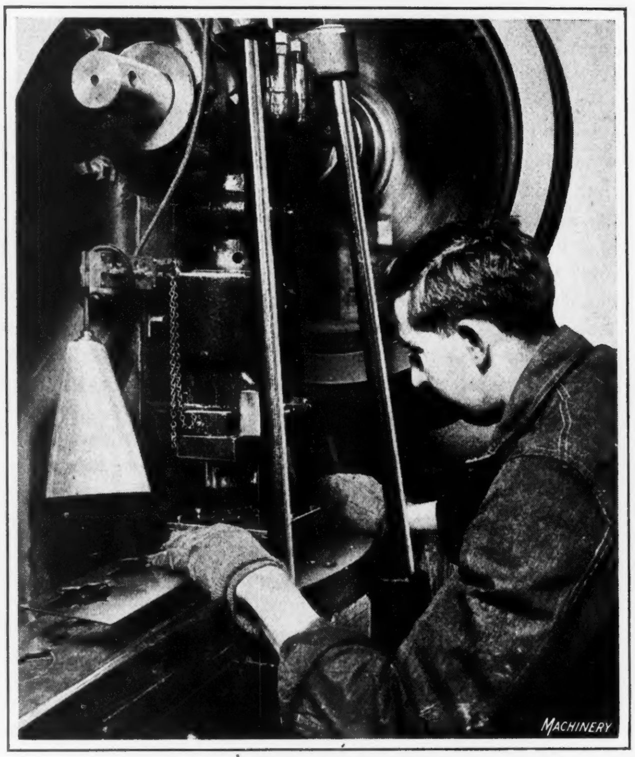


Fig. 6. Power Press equipped with Simple Stamping Dies for making the End Plates of Variable Condensers

so that it may be either attached to a panel or furnished with a suitable base or pedestal for use on a table.

There are three condensite plugs *A*, two of which contain a hinged pin molded in place, by means of which they may swing from side to side. The plugs are also molded with suitable inserts for "plugging in" the coils. The coil is shown in the lower part of the illustration, the plug by means of which the coil is plugged in being indicated at *B*. A spring contact point *C* is assembled to the stud in each of the plugs *A* and *B*, the spring contact being provided to furnish a good connection. The positions of the coils after being plugged into the coil mounting are regulated by means of segment gears *D* which are operated by the bakelite knobs *E*. The middle coil is stationary, the swinging of the side coils varying the "coupling" of the circuits.

At *F* the shape of the spring contacts before forming is shown. These contacts are made from copper, 0.01 inch thick, and the blanks are formed into a thimble shape in two simple press operations. The contacts are punched out with the arms of the star-shaped blank at an angle so that the scrap stock between two punchings may be utilized as spacing washers, thus reducing the amount of scrap. An-

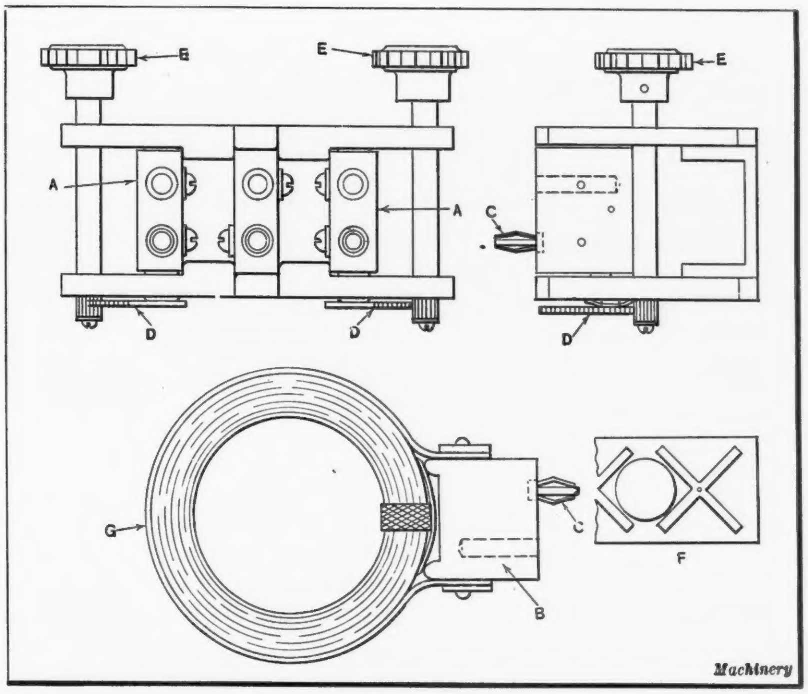


Fig. 7. Honeycomb Inductance Coil Mounting, Assembled Coil, and Diagram of Stock from which the Contact Springs are stamped

other example of power press work in connection with the inductance coil mounting is the punching out of the segment gears *D*, which is done in one operation. The honeycomb coil contains a special winding, and is surrounded by a strip of fiber *G* by means of which it is bound by suitable clips to the plug *B*. Something will be said about the method of winding these coils in a subsequent article, in which several coil windings will be described.

There are comparatively few examples of sheet-metal drawing found in radio work. One of the drawing operations, however, is the forming of the cup in which the galena or other crystal of a crystal detector set is mounted. This crystal mounting contains four miscellaneous examples of press work, which are illustrated in Fig. 8. The cup *A* is made of No. 20 gage (0.0320 inch) B & S sheet brass, and is nickel-plated and buffed. The crystal detector cover *B* is also made from sheet brass, and is nickel-plated, the stock being 0.010 inch thick. The crystal detector ball-sleeve support *C* is made from No. 20 gage phosphor-bronze; this unit is used for producing the universal movement of the contact wire or "cat's whisker." It is necessary, in regulating a crystal detector, to manipulate the contact point until a sensitive spot is found on the galena crystal, and this is done by the use of a ball joint. The crystal holder *D* is made from No. 20 gage (0.0320 inch) B & S stock, and this is also nickel-plated and finished by buffing. These four parts are fairly representative of radio press work other than straight stamping operations.

Pointers for rheostats and control knobs of the type shown at *E* are used in large quantities in radio equipment; these are made from phosphor-bronze and usually assembled to a knob by riveting. The piece of work shown at *F* is a holder for a loud-speaking horn, which is used on the amplifying units of radio receiving sets. This piece consists of a washer punched from flat stock and a threaded sleeve made on a screw machine, the two parts being assembled by spinning.

The use of lathes, drilling machines, engraving machines, tapping machines, and miscellaneous equipment in radio shops will be described in July MACHINERY.

FOREIGN TRADE CONVENTION

The ninth national foreign trade convention held in Philadelphia, Pa., May 10 to 12, attracted a great number of manufacturers and business men from all over the United States. One of the especially valuable features of the convention was the individual advice service in regard to specific foreign trade problems provided for delegates. Appointments were made in advance for those who wished such advice to meet men who were qualified to give them the required information. Among the topics on which advice of this kind was sought and given may be mentioned the following: Financing foreign sales under existing conditions; freight forwarding; contingencies which a marine insurance policy should cover; how to utilize foreign advertising; credit risks and methods of obtaining credit information; preparing salesmen for work abroad; developments in Edge Law banking; the part of the export commission house in foreign sales promotion; how to start an export or import business; protection of trademarks and patents abroad; the use of parcel post for foreign distribution; foreign taxation of American companies and representatives; methods and advantages of forming foreign subsidiaries; relative value of different sales methods; proper use of acceptances; market conditions in various foreign countries; and foreign markets for various commodities. Many papers were read, dealing with almost every conceivable phase of foreign trade. Copies of these papers may be obtained by applying to the Secretary of the National Foreign Trade Council, 1 Hanover Square, New York City.

* * *

The American Engineering Standards Committee has approved as tentative American standard the specifications of the American Society for Testing Materials for cold-drawn Bessemer steel automatic screw stock, cold-drawn open-hearth steel automatic screw stock, methods of chemical analysis of manganese-bronze, and methods of chemical analysis of gun-metal. Copies may be obtained from the American Engineering Standards Committee, 29 W. 39th St., New York.

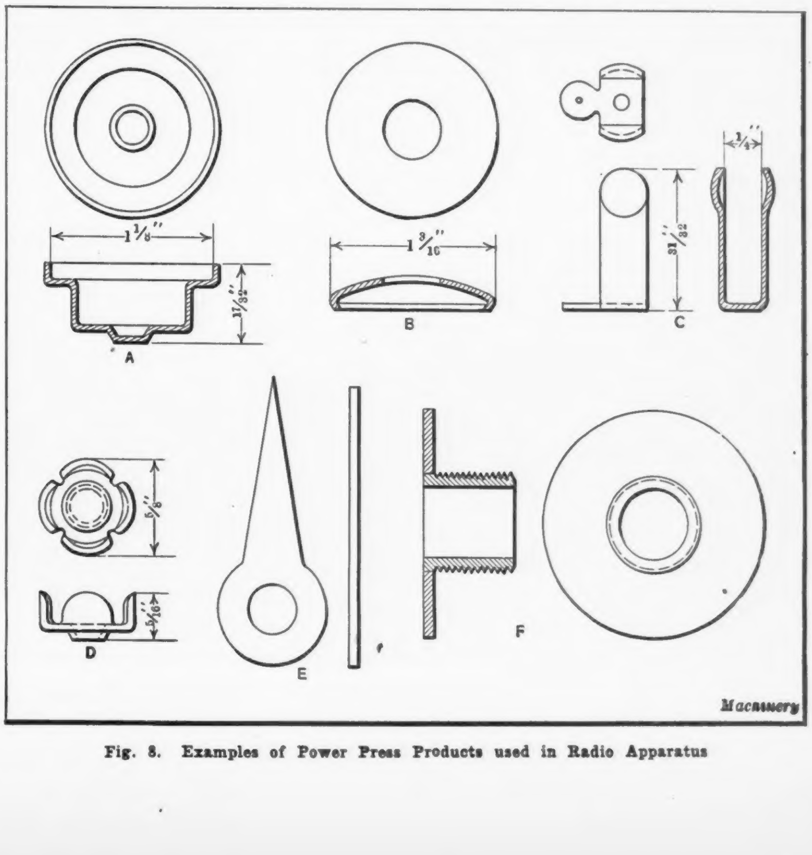


Fig. 8. Examples of Power Press Products used in Radio Apparatus

Power Transmission by Belting

Characteristics of Leather Belting and Charts for Simplifying Calculations

By PETER F. O'SHEA, in Collaboration with Engineers of the Graton & Knight Manufacturing Company

BELTS are rated by the manufacturer as being fit to transmit certain horsepower, but these ratings apply when the pulleys are of equal diameter and the arc of contact is 180 degrees. When the pulleys are of different diameters, the arc of contact is lessened, and it is necessary to decrease the ratings of belts. A wider belt must then be used in order to maintain the desired overload capacity. Any other condition that will decrease the capacity must be carefully considered, as it is necessary to maintain an overload capacity for satisfactory service.

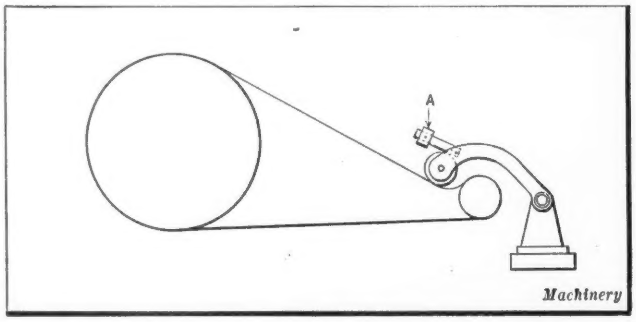


Fig. 1. Swinging Idler on which the Pressure on the Belt may be varied by Means of Weight A

Sometimes the ratings of belts are increased by increasing the arc of contact through the use of idler pulleys, but this practice should be discontinued, as any increased rating above that given for a 180-degree arc of contact is merely a use of the overload capacity of the belt, and, as such, shortens its life. For this reason, the use of idlers in new designs should be abandoned whenever possible. On old drives, however, where the horsepower that must be transmitted has been increased because of additions to the plant, it sometimes seems advisable to install an idler to compensate for the increased load, rather than to go to the expense of installing a new drive.

The method of lacing or fastening the ends of a belt has an important bearing on its capacity. In a test, a belt laced with one of the best types of wire lacing transmitted approximately 15 per cent less horsepower than an endless belt made of the same material and of the identical width. It is therefore evident that belts should be made endless whenever convenient.

Vertical Drives

In vertical drives the arc of contact is often greatly reduced because of the weight of the belt and its stretching under load, which enables the belt to fall away from the lower pulley. When the latter is small and the upper pulley large, a reduction of 50 per cent in the belt efficiency may result, and so a liberal allowance must be made in designing the drive. Failure to observe this point accounts for a large share of the trouble experienced with belts on vertical drives. Thin wide belts have been found to give the best results in drives of this type.

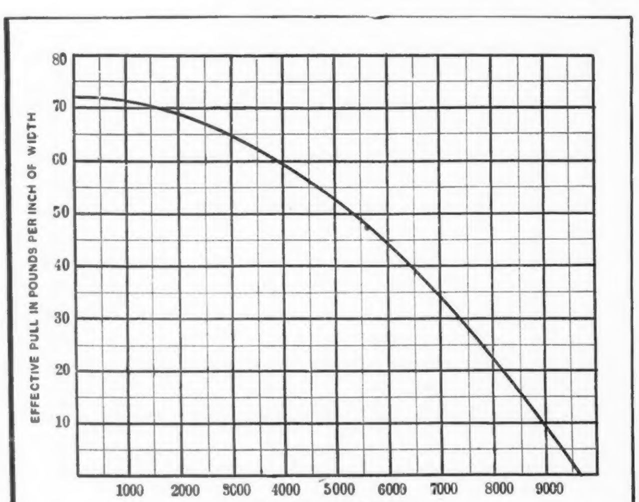


Fig. 2. Chart giving Effective Pull in Pounds per Inch of Width for Single-ply Belts, 3/16 Inch Thick used on Pulleys of Equal Diameter

For machines such as power presses, hammers, and planers, on which the load is irregular and shows frequent high peaks, the belt must have a rated capacity equal to the peak load in order to give satisfactory service. In general, to count upon using the overload capacity of the belt for continuous service is to design the drive for a much shorter life than is good practice. On the other hand, while a belt much too large for the work may have an extremely long life, the increased investment involved on the larger belt, as a rule, is not justified.

The coefficient of friction of a piece of leather depends to a large extent on the amount of wear to which it has been subjected. A worn belt which has been well nourished by judicious dressing, and otherwise has received good care will have a higher coefficient of friction than a new one; this shows that the power-transmitting qualities of leather improve with use. A hard-rolled, highly polished belt has a low coefficient of friction and is a poor transmitter of power, while a soft-finished and pliable belt usually possesses a high coefficient of friction.

Relation of Belt Thickness to Pulley Diameter

The type and weight of belt to use on different drives is just as important a consideration as the horsepower rating. In fact, in order to insure that a given belt will transmit its rated capacity, it is necessary that the belt be suitable for the drive. One of the most important factors is the ratio of the thickness of the belt to the diameter of the pulleys over which it must run. This is shown clearly by a test of the horsepower developed by two belts of different weights and thicknesses. In order to obtain a marked difference the motor pulley used was smaller in diameter than the size that would be employed in practice for belts of the thickness used. The belts were new, one being 9/32 inch thick, and the other 1/4 inch thick. They were run from a 4-inch pulley to a 24-inch pulley at a speed of about 1080 feet per minute. At this speed the rated capacity of the thicker belt was 14.4 horsepower and of the other belt, 11.5 horsepower. In the test, however, the heavier belt transmitted only 10 horsepower at 2 per cent slip, while the lighter belt transmitted 13 horsepower at 2 per cent slip. Thus, the thicker belt did not transmit as much power as the thinner one, and, in addition, a run of less than one hour of the thick belt caused it to become so hot that it was evidently incapable of continuing for several hours under these conditions without burning seriously and failing on the drive. In the case of the thinner belt, a series of tests extending

over several days did not damage the belt in any respect, but rather improved it. These facts show the importance of properly selecting the belt for the drive, as the best belt made may fail utterly if used under unsuitable conditions.

Speed as a Factor in the Selection of Belts

The belt speed is an important consideration in this connection, the heating of the belt being dependent upon the rate at which the belt passes over the pulleys. For this reason, belts running at slow speeds may be safely run over small pulleys, while belts run at high speeds may be unsatisfactory. A belt running at a high speed must be uniform in thickness and well balanced. If a belt runs under little or no load and at a fairly high speed, it will sway from side to side and may run off the pulleys. High-speed belts should not be larger in either thickness or weight than is necessary to carry the load, because when the belt passes around the pulleys and the direction of belt travel is reversed, there is a momentum which must be overcome. This momentum depends considerably upon the size of the belt.

Belts running at high speeds over small pulleys should always be made with waterproof cement, as this material resists the heat generated by the bending and slipping of the belt and does not granulate as easily as ordinary cement. All high-speed belts should also be of the endless type, because any fastener throws the belt out of balance, causing it to flop and perhaps run off the pulleys.

Belts used in damp and wet places, and those exposed to cutting and grinding fluids, should be made with waterproof cement and be waterproof-dressed. Machine oil has a deteriorating effect on belts, and every effort should be made to prevent its coming in contact with belting. When it is impossible to prevent this, a brand of belting should be used which is as nearly as possible oilproof. Certain brands resist the alkali in cutting and grinding fluids, whereas an oak belt would be ruined by it. Oak leather belting should not be run in places where the temperature is higher than 115 degrees F., because the leather is likely to be damaged and the cement softened.

CORRECTION FACTORS FOR DIFFERENT WEIGHTS AND THICKNESSES OF BELTS

Single-ply Belts			Double-ply Belts		
Thickness, Inch	Ounces per Square Foot	Factor	Thickness, Inch	Ounces per Square Foot	Factor
$\frac{9}{64}$–$\frac{5}{32}$	12–14	0.8	$\frac{13}{64}$–$\frac{1}{4}$	22–26	1.28
$\frac{11}{64}$–$\frac{3}{16}$	14–16	0.9	$\frac{1}{4}$–$\frac{9}{32}$	26–29	1.44
$\frac{3}{16}$–$\frac{13}{64}$	16–18	1.0	$\frac{9}{32}$–$\frac{11}{32}$	29–33	1.60
$\frac{7}{32}$–$\frac{1}{4}$	18 up	1.1	$\frac{11}{32}$–$\frac{13}{32}$	33 up	1.76

Machinery

Belts used on shifting drives should have round edges and possess sufficient lateral stiffness to prevent the edge from curling through contact with the shifter. The same is true of belts running on cone pulleys, and, in this case, the belt should not be the full width of the pulley face; this is a mistake that is commonly made. Shifting belts should also be made endless if possible; otherwise the shifter may catch on the fastener and tear the belt. If an endless belt cannot be used, the ends should be laced tightly together.

Idler Pulleys

As previously mentioned, in cases where a belt is being used in a drive consisting of two pulleys of different diameters, the capacity of the drive may be increased by the use of an idler pulley. The general rule is to place the idler on the slack side of the belt, near the small pulley, so that the arc of contact on the latter will be increased. This arrangement increases the capacity, decreases the slippage, and lessens the tension under which the belt operates. When the tight side of the belt is on top, an idler is of special advantage.

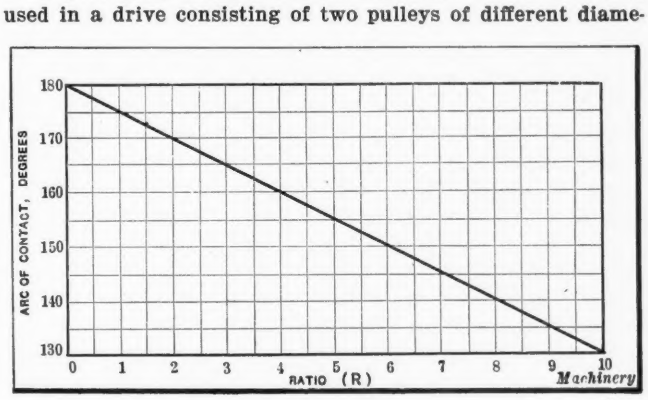


Fig. 3. Chart for determining Belt Arc of Contact on the Smaller Pulley when the Distance between the Pulleys and their Diameters are known

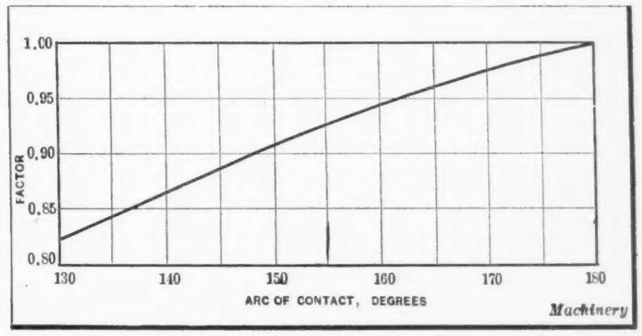


Fig. 4. Correction Factor Chart for Pulleys on which the Arc of Contact is other than 180 Degrees

Screw adjustment idlers are often used successfully, but one trouble with idlers of this type is the danger of imposing an excessive amount of strain on the belt—a point which cannot be too strongly emphasized. Swinging idlers of proper construction cause the belt to wrap the pulleys efficiently, and automatically take up the slack caused by the stretch of the belt under load. They permit the belt to be run very slack, thus decreasing friction in the bearings and eliminating excessive stretch. Idlers of all types must be carefully lined up or they will cause the belt to run off the pulleys. Adjustable idlers are often misaligned through carelessness in making the adjustments, while swinging idlers sometimes work loose and lose their alignment.

An excellent type of swinging idler is shown diagrammatically in Fig. 1. Weight *A* may be varied to take care of different conditions, but should never be excessive. One of the chief advantages of this construction is the short center distance which it makes possible between the pulleys. Such an installation may replace geared, friction, chain, and rope drives. In using any idler, it is necessary to avoid too sharp a bend in the belt between the pulley and the idler, as belts often crack and break under such conditions. A fixed idler pulley is frequently necessary in order to make a belt clear a beam or some other obstruction. In such cases, it is permissible to place an idler on the tight side of the belt, but the action is not that of a true idler. Whenever an idler is used in this manner, it should be looked upon as a necessary evil, since the frictional load on the belt is increased.

Belts running under their rated capacities should have a slight sag on the slack side, which shows that there is no excessive tension, resulting in an unnecessary bearing friction that would cause burnt bearings. Calculations of the capacity of belts are usually based on a low starting load, and if a heavy load is to be applied suddenly, a belt with a high rating should be employed. A high starting torque causes an initial stretch in the belt which cannot be easily calculated. If a tight belt is forced on the pulleys, a crooked spot will develop at the point where it is strained, and a diagonal crease across the belt also indicates that the belt has been too tight on the pulleys.

Charts Simplifying Belt Calculations

A number of charts developed by the Graton & Knight Mfg. Co. to simplify the calculations of belt drives are pre-

sented herewith. These charts are applicable when the conditions are good and the belt has been well taken care of. The effective pull per inch of width for a single-ply belt, 3/16-inch thick, weighing from 16 to 18 ounces per square foot, may be determined by the chart, Fig. 2, for various speeds up to 9500 feet per minute. This chart is based on the use of pulleys of equal diameter having 180-degree arcs of contact, and so, when the pulleys are of different diameters, a certain correction must be made in the values given. The correction factors for different arcs of contact may be read from the chart in Fig. 4.

Corrections must also be made when the belts are of different thicknesses and weights from those on which the chart in Fig. 2 is based, and these correction factors are given in the accompanying table. The chart in Fig. 3 enables the arc of contact on the smaller of two pulleys to be determined when the diameter of both pulleys and their center-to-center distance are known.

The method of using these charts will be apparent by an example: What horsepower may be transmitted by a single-ply belt, 4 inches wide, weighing 15 ounces per square foot, and running at the rate of 4200 feet per minute over two pulleys, 60 and 12 inches in diameter, respectively, the center-to-center distance between the pulleys being 12 feet? Referring to the chart in Fig. 2 the effective pull for a belt weighing from 16 to 18 ounces per square foot, having an arc of contact on the smaller pulley of 180 degrees and running at a speed of 4200 feet per minute, is found by approximating 4200 on the bottom line of the chart, following a vertical line from that point up to the curve, and then following a horizontal line to the left side of the chart, where the effective pull is found to be about 58 pounds per inch of width.

As the pulleys are of unequal diameter, a correction must be made for the arc of contact, by the use of the chart Fig. 3. In order to use this chart, ratio R must be calculated; this ratio is equivalent to the difference in the diameters of the two pulleys in inches, divided by the center-to-center distance between the pulleys in feet. Thus in the problem under consideration, $R = (60 - 12) \div 12 = 4$. The arc of contact is then found by locating 4 on the bottom line, following the corresponding vertical line to its intersection with the diagonal line and then following the horizontal line at this point of intersection to the left side of the chart. The arc of contact in this case is found to be 160 degrees.

The correction factor for this arc of contact is found from the chart in Fig. 4 by first locating 160 on the bottom line of the chart, then following the perpendicular at this point to the intersection with the curve, and finally following a horizontal line from this point to the left side of the chart. In this case the factor is about 0.94. From the table, the correction factor for a belt weighing 15 ounces per square foot is found to be 0.9. With these values known, the effective pull of the belt per inch of width may be calculated as follows: $0.94 \times 0.9 \times 58 = 49$ pounds.

The horsepower which the belt is capable of transmitting may then be calculated by the formula:

$$\text{H. P.} = \frac{SVW}{33{,}000}$$

in which

S = effective pull of belt per inch of width, in pounds;
V = velocity of belt, in feet per minute; and
W = width of belt in inches.

Inserting the known values in this formula:

$$\text{H. P.} = \frac{49 \times 4200 \times 4}{33{,}000} = 25$$

For a double-ply belt the effective pull determined from the chart in Fig. 2 should be multiplied by 1.6.

[An article published in March MACHINERY, entitled "Charts for Determining Belt Widths" has been criticised on the ground that the belt widths indicated by the charts for transmitting a given horsepower are excessive according to the results of tests and the recommendations of leather belting manufacturers. Wide differences of opinion exist as to the power-transmitting capacity of belts, and the relatively low values represented by the charts previously published are evidently intended to provide belt drives that will reduce, to a minimum, maintenance costs and manufacturing losses due to interruptions incident to belt repairs. According to some investigators, it is economical, in the long run, to use a belt that is wide enough to permit a much lower effective tension value than is usually recommended, the object being to minimize total costs throughout the life of a belt instead of considering largely the initial cost of the belt itself.

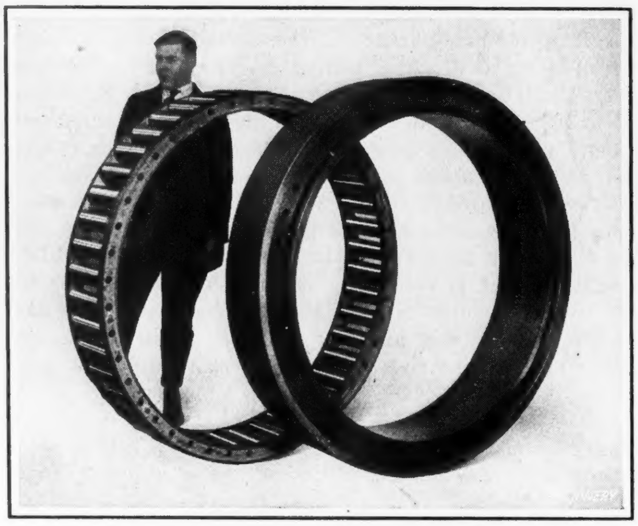
While it is true that a comparison of belts operating under different tensions should take into account all losses during the life of each belt, the quality of belting is a factor that must not be overlooked, as it decidedly affects the allowable working stress, permitting higher values for the better grades of belting with the advantage of lower initial costs. It is evident, therefore, that effective tension must also be related to belt quality although this introduces a variable that is difficult to provide for in any general formula.

The power transmitting capacities of belts as determined in connection with the foregoing article are much higher than those given by the charts previously published. We believe, however, that the information given in this article represents approved practice as applied to good leather belting and as determined by recent tests, although apparently even more extensive experiments and tests will be necessary before the power ratings for belts of different kinds and grades are definitely established with reference to all factors that should be considered.—EDITOR]

* * *

LARGE ROLLER BEARING

The accompanying illustration shows a very large roller bearing recently completed by the Railway Roller Bearing Co., Syracuse, N. Y., for the United States Navy Department. The working load of this bearing is 65,500 pounds, and in testing, it was submitted to a load, while rotating, of 90,000



Large Roller Bearing having a Working Load of 65,500 Pounds

pounds, and to a static load of 113,500 pounds. The bearing is assembled from 44 rollers, each 10¾ inches long and 3 inches in diameter. The width is 13¾ inches; inside diameter, 49 inches; and outside diameter, 59½ inches.

* * *

The National Safety Code Committee of the American Engineering Standards Committee has changed its name to the Safety Code Correlating Committee. This committee gives out all national safety codes to the sponsor bodies. The sponsor bodies form representative sectional committees to handle their codes, the personnel of which must be approved by the American Engineering Standards Committee.

Testing Gear and Gear-Cutter Teeth*

By RALPH E. FLANDERS, Manager, Jones & Lamson Machine Co., Springfield, Vt.

THE screw-thread comparator was devised by Mr. Hartness, president of the Jones & Lamson Machine Co. for testing screw threads. The original invention related particularly to a special means of supporting the screw between a source of light and a projection microscope, and a special chart with tolerances indicated on it to receive the projected image. The combination of these novel elements made it possible to inspect all the significant dimensions of a screw thread at a single glance, indicating the degree of error in outside diameter, pitch diameter, root diameter, form, lead, quality of finish, etc., and, more important still, the total effect of all these errors on the fit of the screw in a standard hole for any desired length of engagement. Since some of the elements are common to both thread testing and gear testing, the machine will first be considered briefly as a thread-testing apparatus.

An arc lamp is used ordinarily as a source of light. Its brilliance permits the apparatus to be set in any suitable dimly lighted location, a completely dark room being desirable but not necessary. The small area of the light source also adds to the sharpness of the image—a prime requirement where accuracy is desired. The microscope is of a special construction, the problem solved in this microscope being that of getting a magnification of 200 diameters at a distance from the operator of about five feet, without chromatic diffusion (that is to say, without having the edges of the image show wide bands of color instead of clear, sharp black and white), and without measurable distortion.

Now it is easy enough to meet these requirements if the screen or chart is permitted to be forty or fifty feet away. It is likewise easy enough to get the magnification at close range and with a sharp outline if we do not care about distortion; or with an undistorted image if we are not troubled about hazy color bands instead of a sharp edge to the shadow. But to get all three conditions of nearness, sharpness and accuracy of image is very difficult. The writer believes this result has been attained in this microscope to a degree hitherto unknown.

The machine is a comparator as its name indicates. The final standard is not the outline on the chart, but the plug gage whose shadow is set to coincide with the chart. This principle of using the apparatus as a comparator is followed in the measurement of gear and cutter outlines in that they are ordinarily referred to an outline on an actual standard instead of to a drawn outline on a chart. The advisability of this will be discussed later.

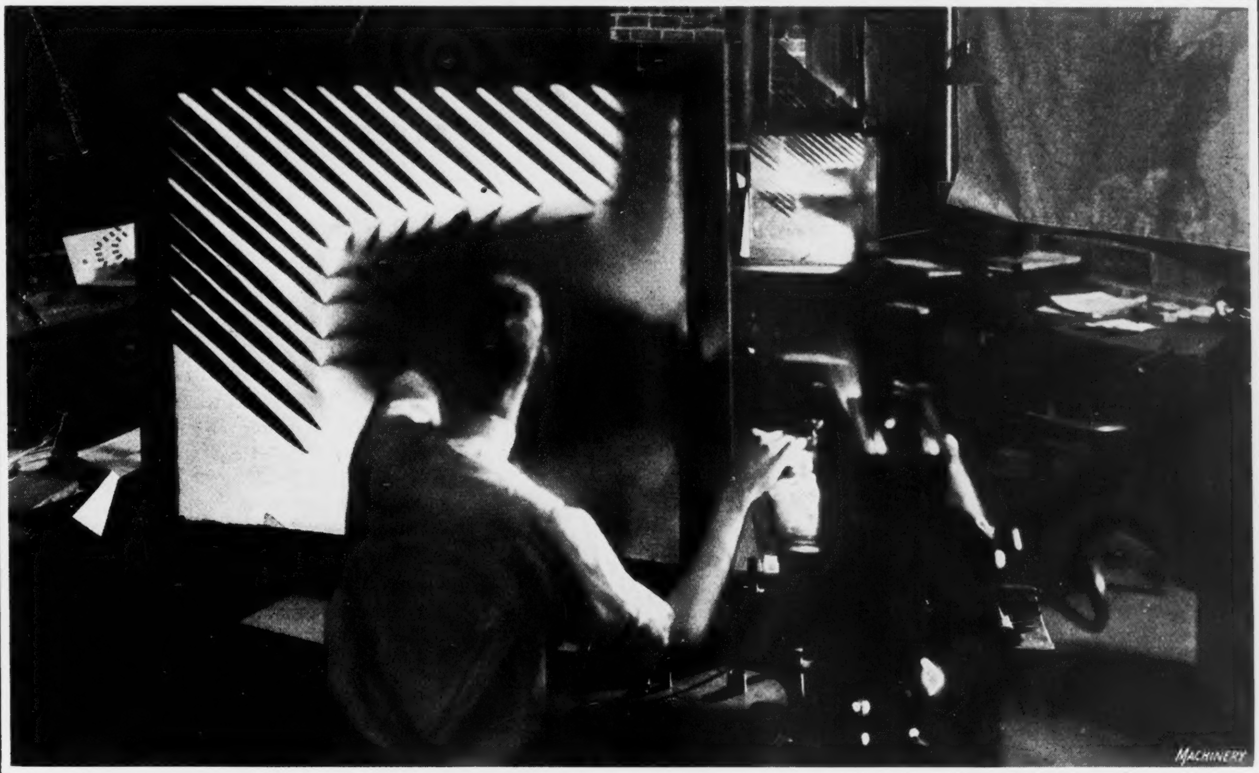


Fig. 1. Testing Outline of a Gear Tooth, the Image of which is reflected against the Mirror seen in the Background and then forward to a Ground Glass Screen at the Operator's Position

Inspection of Gear-cutters

The simplest application of the machine is for inspecting gear-cutter outlines. The cutter is mounted on a true arbor between dead centers in front of the lens. The microscope, in this case, must have a large aperture to take in the whole tooth. A stop is provided against which the cutting face registers to keep it in the vertical plane for which it is focussed.

Now to get the required degree of magnification (say 90 or 100 diameters for the work) at a distance of five feet, where the operator can observe it and at the same time manipulate the work, would require an angle of projection so wide that no lens system can be devised to preserve both freedom from distortion and achromatism (or freedom from color bands). Therefore the image was reflected against a

*Abstract of a paper read before the American Gear Manufacturers' Association's convention, April 20.

mirror placed at a distance (see Fig. 1) and then back to the operator's position where it is received on the back of a ground glass screen. On the front of this screen the operator can work freely, drawing lines or erasing them, comparing the image with his drawings, etc., all without throwing his own shadow on the screen at the operating position. Another point of equal importance is that a considerable group of men can examine the image at close range without interference.

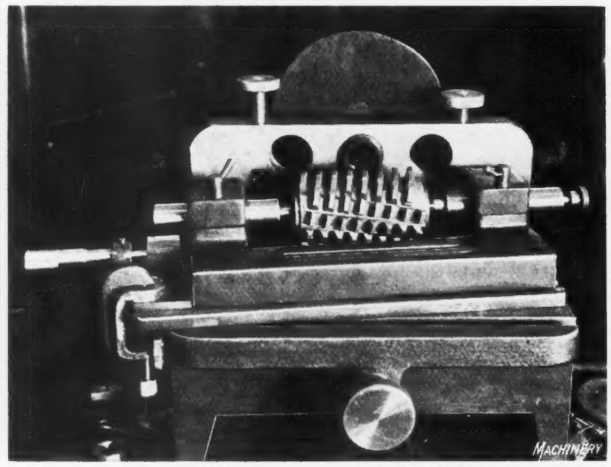


Fig. 2. Hob in Position for testing Accuracy

The mirror is not an ordinary one with a "silvered" or amalgam back, but has an actual deposit of silver on its front surface from which the reflection is made. This is the same method as that used in coating the parabolic mirror of reflecting telescopes. This gives a more nearly total reflection of the light, and above all avoids the double reflection from both front and back faces of the ordinary mirror. The accuracy of the result can be judged from the fact that with a magnification of 100 diameters, differences of 0.0001 inch can be detected.

Testing Uniformity of Form Cutter Teeth

When projecting a form cutter, a most direct and valuable use of the machine lies in testing the regularity of the teeth, one with another. If the outline of the first tooth projected is carefully drawn on the screen, successive teeth may be indexed around into position and compared with the first one. By this means differences in outline may be discovered, whether due to hardening distortion or to inaccurate grinding and also any inaccuracy of the teeth, either sidewise or radial. Furthermore, the teeth of a cutter giving satisfactory results may be compared with one that is not satisfactory and the reasons determined. By reversing the cutter on the arbor it can be seen whether or not the tooth outline is symmetrical. The foregoing relates to the use of the machine as a comparator. The use of this or any other projection apparatus for the direct comparison of tooth outlines with diagrams drawn to an enlarged scale is a more difficult matter—more of a laboratory job than an ordinary shop process.

Testing Accuracy of a Hob

In Fig. 2 is shown a hob mounted for testing on the comparator. The inspection is carried out in somewhat the same way as for a cutter, but, in this case there is the additional element of lead variation to consider. This is taken care of by mounting the hob arbor between centers which are carried by a frame rolling on ball bearings in tracks machined in the base of the device. The advance of each tooth is measured by matching it with an outline on the chart, and reading the axial distance through which it has moved by means of the micrometer or precision measuring blocks, or both.

The center line of the hob must be set at the proper angle to bring the face of the tooth to be inspected as nearly as possible in the focal plane. This angle is presumably the helix angle of the hob, measured at or near the pitch diameter. A stop is used preferably to locate the cutting edge in the focal plane. It should be noted, however, that the stop can be omitted by an expert, as bringing the outline to a sharp focus indicates that it is within less than 0.001 inch of the required position. A movement of this amount either way will blur the outline. This incidentally shows the excellence of the microscope objective.

Method of Projecting and Testing Gear Shaper Cutters

A fixture for projecting spur gears or cutters of the Fellows gear shaper type is shown in Figs. 3 and 4. Fig. 4 shows the fixture with a cutter mounted in place. There is a frame carrying a stud on which the gear or cutter is mounted, and an index-pin or spring plunger carried in a holder adjustable for diameter. This pin has a conical point to engage and locate the tooth space. The stud on which the gear or cutter is mounted is cut away to give two fixed contacts on the side toward the index-pin. In the case of gears with holes varying in diameter, this insures a nearly uniform presentation of the teeth to the microscope.

When testing the gear shaper cutter (Fig. 4) the following important points should be noted: First, the tops of the teeth are not ground square but at an angle of 5 degrees, so that it is necessary to set the attachment at that angle on the work-table of the machine to bring the cutting edge uniformly into the focal plane. Second, in comparing one cutter with another, due to the nature of the relief on the cutter, the image must be brought to a focus, not by shifting the cutter along the optical axis by the regular focussing screw, but by shifting the cutter along its own axis which

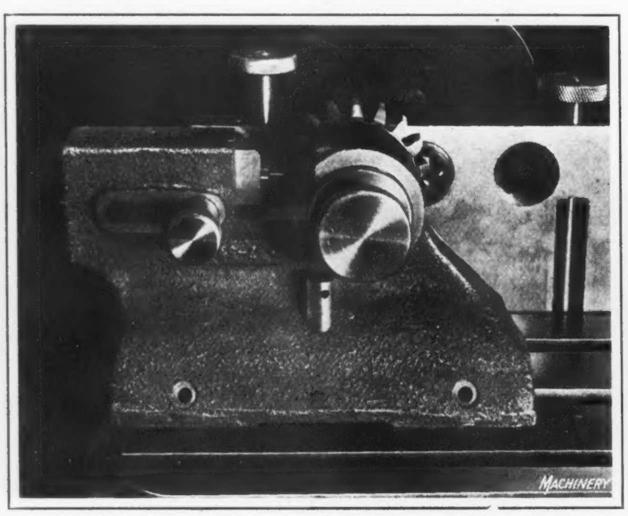


Fig. 3. Front View of Fixture used for projecting Spur Gears or Gear Shaper Cutters

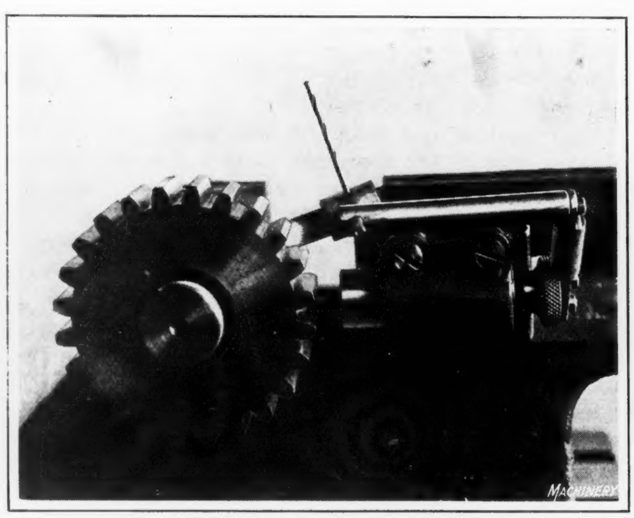


Fig. 4. Opposite Side of Fixture shown in Fig. 3, with Attachment for Gear-testing in Position

is at an angle of 5 degrees with it. Otherwise the comparison will be worthless.

Two kinds of tests may be made with the gear shaper cutter. The first is for indexing. In this test an outline of one of the teeth is drawn on the screen, and then successive teeth are indexed past this outline and the amount of variation in position is noted. The other, and perhaps more interesting test, is comparing the outlines of the different teeth on the same cutter, or the teeth on one cutter with those of another, or with a standard made for the purpose. In this case the accurate index-pin previously used is replaced by one having a point slightly eccentric. By turning this pin, the cutter can be very delicately rotated to bring the image of each tooth accurately into coincidence with the drawn diagram, irrespective of any slight errors that may occur in indexing.

Besides the precautions previously mentioned, other points inherent in the involute system must be observed. The thinner tooth of the ground down cutter, as compared with a new one, is an essential for theoretical accuracy, and not a mistake. Within certain limits, changes in shape at the fillets, or anywhere below the base circle of the cutter, do not affect the acting surfaces of the cutter or of the gear cut. In the event of an attempt to compare cutter outlines with drawn diagrams, due consideration must be given in this case, as in all others, to the precautions mentioned previously. In this case also the most satisfactory use of the machine is as a comparator, or in other words, as a means of comparing outlines with each other or with a standard, rather than with an unregistered diagram.

Fig. 5. Needle mounted and focussed in Plane to be tested

Method of Testing Spur Gears

Projecting cutter outlines is comparatively simple, owing to the sharp, definite nature of the cutting edges, but testing gears is a more difficult problem. The edge is rubbed over on the entering side of the cut and provided with burrs on the other side, which cannot be removed with any assurance that the true outline will be retained. Worse than this, many gears, especially in automobile work, have the teeth chamfered at one or both edges, thus making a reliable outline impossible. Until recently, the best method available was to clamp a thin sheet of metal between two thicker blanks of the same material and cut teeth in all at the same time. This produced a thin templet, which was practically free from burrs and of correct outline, thus being suitable for projection. Theoretically this was all right, but such a gear could not be tested in actual running, nor could it be compared with one that had been run. The problem was thus practically unsolved. What was needed was some method of projecting and tracing the tooth outline on any section from one end to the other. This difficult problem was solved in a very simple manner by Messrs. Beardsley & Porter, of the Jones & Lamson Machine Co.

If a gear with ground, lapped, or otherwise polished tooth surfaces is placed in the fixture shown in Fig. 4, and the device clamped on the work-table so that it makes a slight angle with the optical axis (say, 1 degree) in a direction that tends to display the tooth surfaces to the microscope, an interesting thing may be observed. The diagram on the screen tends to show an outline on the focal plane, whether that be located close to one end of the tooth or somewhere midway. This is due to the fact that the microscope tends to define anything in the focal plane and confuse everything else. Owing to the "thinness" of the focal plane of these special microscopes, the infinitesimal details thus picked out tend toward a sharp outline, but the outline is not sharp enough for practical purposes. How shall this outline be developed?

This was done in a most simple manner. As shown in Fig. 5, a needle was mounted and focussed in the plane it was desired to explore, and then the tooth outline was traced by its point. The junction of the point and its reflection, furnished a location for the surface measurably

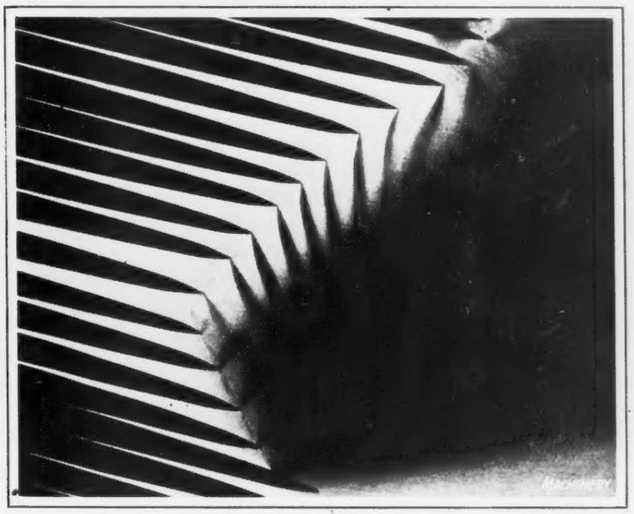


Fig. 6. Image of Gear Tooth and Needles as seen on Screen

accurate within 0.0001 inch; and it made possible the rapid drawing of the outline with nearly this degree of accuracy. With the outline once drawn, other teeth of the same gear, or of other gears, can likewise be indicated with the moving needle point, and compared with the drawn outline.

For extreme accuracy, the reflected image of the needle is required, but this does not confine the use of the process to highly polished surfaces. Even roughly cut hardened gears, with the black of the furnace on them, show some reflection under the glare of the arc. The conclusion is that, in general, any ordinary gear will show reflection enough to allow measurement in reasonable proportion to the accuracy of the surface measured.

What promises to be the most practical application of this principle is embodied in the device shown mounted above the index-pin in Fig. 4. A whole battery of needles is laid side by side in the shallow groove of a suitable holder and held in place by a sheet rubber pad which is placed between them and a rotatable spindle (shown in the illustration as a small twist drill). When a gear is mounted in the fixture, and the spindle is revolved between the fingers, the needles approach the tooth outline, stopping in contact with it for its entire length from top to root. Fig. 1 shows the whole apparatus at work, with the inspector in the operating position, and Fig. 6 shows the image on the screen. The appearance of these antenna-like projections and their reflections as they approach each other is weird; but it is satisfying as well, for it represents the solution of a difficult and vital mechanical problem.

The French Machine Tool Trade

By W. P. MITCHELL

THE French machine tool market is decidedly dull. It may be merely "blunt" so far as the French home product is concerned, but the word "dull" is mild when it comes to American or British machinery in the French market. On the other hand, there is an influx of the "made-in-Germany" product, which is penetrating to the utmost corners of France. The small shops using machine tools and equipment, and even the small dealers, apparently care little about the origin of what they buy. Furthermore, capital is not available for modernizing plants with the more expensive American or British product, even though it may be acknowledged to be superior, and many French manufacturers are satisfied if they are able to keep the wheels turning part time without any thought of improvements or expenditures.

Three factors have prevented the continuance of business with America—the abnormal exchange, the increased import duties, and the high freight rates. Certain well-known American manufacturers of machinery in the general field, who have their own establishments in France, have been able to meet the conditions fairly well, but other American manufacturers have found it practically impossible to break into the French market at this time. One firm has become affiliated with a French manufacturing concern, and has been able to do more business than could have been done by selling machinery directly imported from America. This method, however, would not be as applicable in the machine tool field as in the general machinery field.

The solution of the problem is difficult, and there is no likelihood that there will be any improvement in conditions in the near future. The tariff duties will not come down, probably, for years, and it is a question, in view of the French financial situation, whether the value of the dollar will fall materially below ten francs to the dollar. When real peace is established again, the situation may improve, but certainly not before the unsecured paper money becomes a thing of the past.

French Tariff Duties on Machine Tools

The French tariff duties on machine tools, per 100 kilograms (220 pounds), in effect at the beginning of this year, are as follows:

	Country of Origin		
Weight	United States	Great Britain	Germany
200 kilograms or less....	50 francs	50 francs	200 francs
200 to 1000 kilograms...	24 francs	24 francs	96 francs
1000 to 5000 kilograms...	16 francs	16 francs	64 francs

The figures given are multiplied by the coefficient in use at the time of importation, this coefficient being now 3.3. The coefficient may be changed by the administration without legislative action. The tariff on German machines is four times as high as the rates for American or British products; but the transportation charges on the German product are only about one-fifth those on American machinery.

Competition with Germany

Because of present exchange conditions, this is what happens when a machine tool weighing say 200 kilograms and selling for $250 in America is to compete with a similar machine from Germany, which may be priced today at, say, 5000 marks. The American machine will cost the French buyer approximately 3000 francs, while the German machine will cost but little over 1000 francs. Obviously, the Frenchman will buy in the German market if he buys at all, as the figures for the imports of machinery into France in 1921 from America, England, and Germany plainly show. There seems to be little doubt that Germany's financial situation must be improved in the interest of the industrial and trading world everywhere. Competition with Germany in nine-tenths of the European buying market is becoming impossible.

It has been pointed out that Germany is no more formidable today industrially as to ability and equipment than she was before the war, and that the rest of the world found enough to do then and will again. This is true, but an adjustment has to be made first. In the depressing dullness of the French trade in 1921, Germany sent machinery to France exceeding in value by 15 per cent the machinery imported from America, and in tools and other metal appliances, Germany supplied approximately four times as much as the United States, and twice as much as England. Another significant fact is that England sent small tools and other metal appliances to France last year to a value twice that of the imports from America. The following figures give the exact values of French imports in 1921:

FRENCH IMPORTS

	Country of Origin		
	United States	Great Britain	Germany
	Machinery and Mechanical Appliances		
Kilograms........	65,347,800	55,946,000	71,028,000
Value, francs.....	331,556,000	385,072,000	386,683,000
	Tools and Other Metal Appliances		
Kilograms..........	5,254,200	13,739,000	20,297,000
Value, francs.......	28,858,000	52,438,000	104,164,000

Improvement in French Industrial Conditions

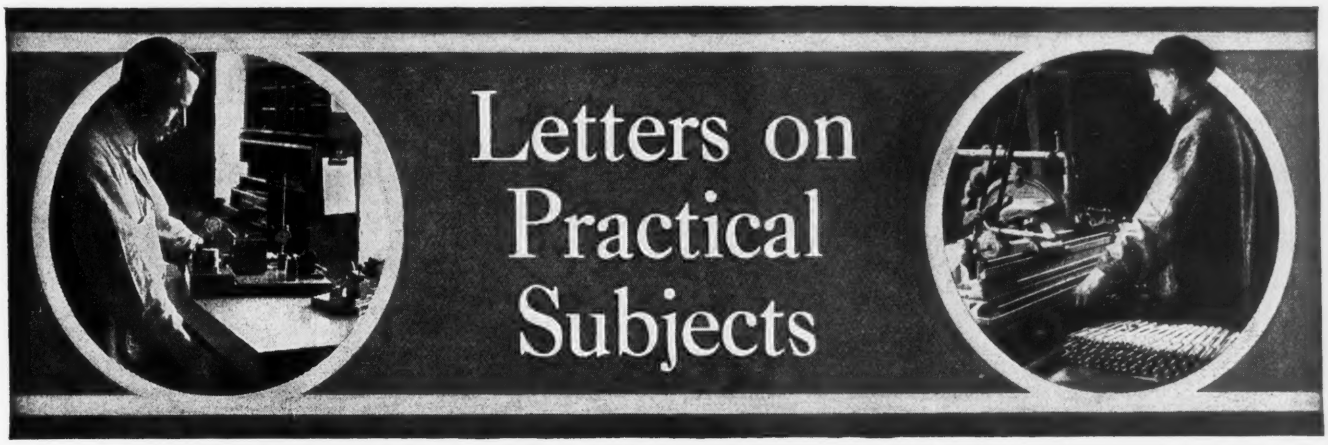
It is true that business in France is improving; at least, production is increasing and, indeed, in 1921, the drop in production in France was considerably less, proportionately, than in either America or England. The increase in the exports of machinery and tools from France to the United States during the last three years is remarkable. The exports of machines, mechanical appliances and tools for 1919, 1920, and 1921 are given below in francs:

	1919	1920	1921
Machines and Mechanical Appliances..	1,742,000	5,565,000	16,411,000
Tools and other Metal Appliances..	1,304,000	9,563,000	69,304,000

By comparing the import and export figures from the United States into France and vice versa in 1921, we find that the French exports of machinery to the United States amounted to only 5 per cent of the imports from the United States, but in the case of tools and other metal appliances, the exports from France to the United States were almost two and one-half times the exports from the United States to France.

Prospects for the Future

In spite of all, there are reasons to believe that there is a future for the market of American machinery in France. To hold that market, however, courage is required, and stocks must be kept for the occasional buyer; an educational campaign must also be carried on, through which the American manufacturer will some day come into his own. Those manufacturers who are selling to France today—and something must have been sold to account for the 1921 imports valued at over 330,000,000 francs of machinery and mechanical appliances—are those who know the ground, who have tilled it and sown. They will reap, but to do so they must be on the ground at the time of the harvest.



MOLDING BARREL CASTINGS

The evolution of a pattern and core-box for use in the production of large quantities of accurate cylinder or barrel castings is described in this article. The principal dimensions of the casting are shown at *A* in the accompanying illustration. The casting was to have core holes at each end 2½ inches square. It was desired to eliminate all machine work, and it therefore became necessary to hold the castings as close as possible to the specified dimensions.

Probably nine out of ten patternmakers would make the pattern with the parting line through the center, and the 2½-inch core-prints attached to the ends of the pattern as shown at *A*, the core-box being designed to produce half-cores that could be pasted together to form the complete core. A mold made from this pattern would, of course, be poured with the casting on its side in the position indicated at *A*. The first pattern was actually made and used in this way, but it proved unsatisfactory, as the core-prints were not large enough to support the core or prevent it from rising in the mold when the casting was being poured.

The second method tried was molding the pattern on end as shown at *B*. This method was also a failure, because it was very difficult to pass the core down through the mold and enter the print properly in the recess in the bottom of the mold. The end face of the core also proved too small to support the heavy core, so that the latter frequently sunk down into the molding sand.

A slab core, such as shown at *C*, was then provided to overcome this difficulty. The slab core was rammed up in the mold in both the cope and the drag. This prevented the core from sinking into the molding sand, but did not eliminate the difficulty experienced in entering the core in the drag. The core-prints were next cut down to the size and shape indicated by the dotted lines at *b* in view *D*. "Ram-up" cores *a* were made to fit over the prints. These cores remained in the mold and provided a hard surface on which to set the core. The castings produced from this pattern were found to vary in thickness, due to the failure of the cope flask to line up properly with the drag. This method of molding was therefore discarded.

The rather unusual method that was finally adopted with success was suggested by the foreman of the foundry. The pattern was made split through the middle and provided with core-prints attached to each end, as shown at *E*. These prints were made 6½ inches in diameter or ½ inch smaller than the diameter of the body core. The core-prints were given a ¼ inch taper, as shown in the illustration. The

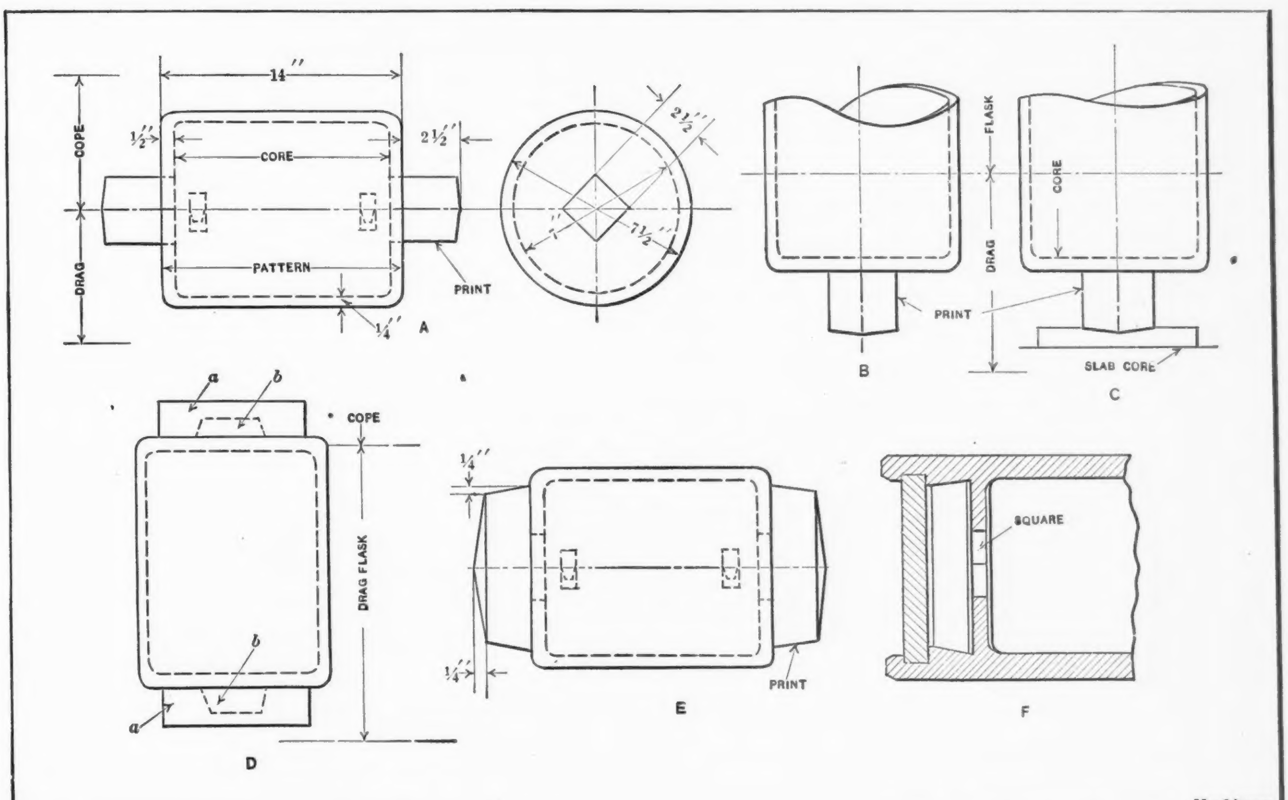


Illustration showing Evolution of a Pattern Core-box for Cylinder or Barrel Castings

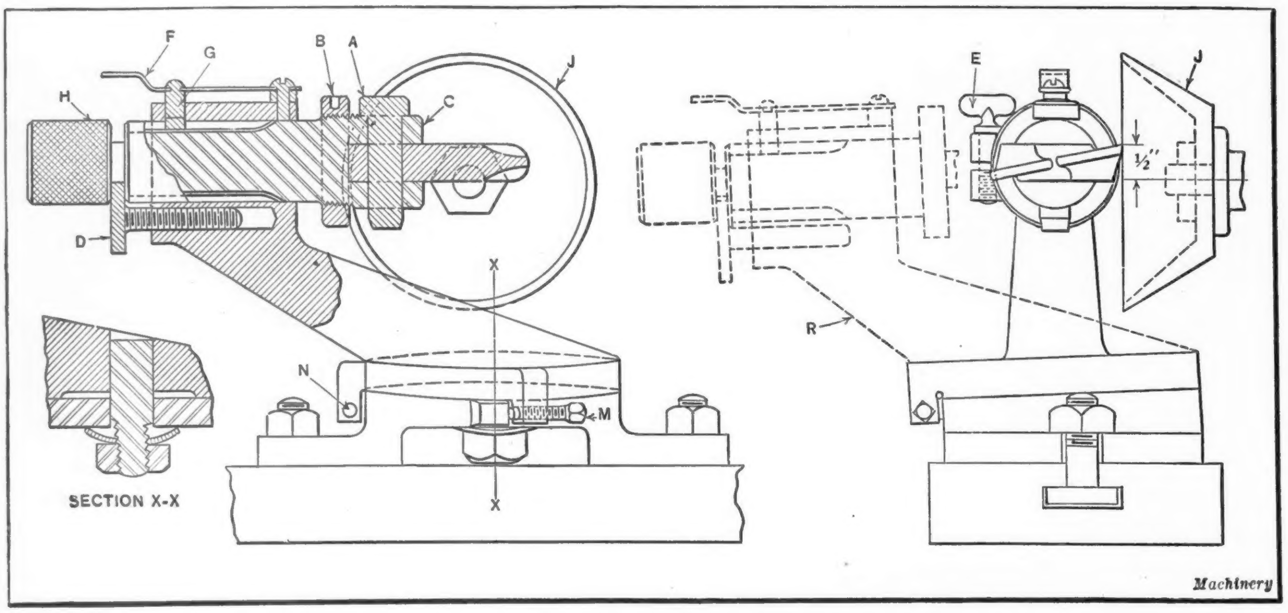


Fig. 1. Details of Reamer-grinding Fixture, a Plan View of which is shown in Fig. 3

core-box for the pattern was made with ends of the shape shown at *F*, particular attention being given to the accurate tapering of the ends of the box. The core-prints attached to this pattern were of sufficient size to support the core properly and hold it in place. With the split pattern and the tapering core-prints, the molder was enabled to mold the pattern either on its side or on its end, as desired.

Kenosha, Wis. M. E. DUGGAN

REAMER AND REAMER-GRINDING FIXTURE

The reamer and reamer-grinding fixture described in this article was designed and placed in successful operation by the writer while engaged as a tool-room foreman in a large shell manufacturing plant. While designed for use in the production of 3.3-inch high-explosive shells, both the reamer and its grinding fixture embody features that can be employed to advantage in the design of tool equipment for various peace-time products.

The reamer, as will be seen from Fig. 2, has a clearance back of the cutting edge of approximately 4¾ degrees. When this type of reamer was first tried out, the grinding of the side and front cutting edges was done on a universal grinder, using a vise to hold the blade. The radius was ground by hand, a profile gage being used to obtain the ½ inch radii. The latter operation alone required about one-half hour. By the use of the grinding fixture shown in Figs. 1 and 3, the total time for finish-grinding was reduced to less than two minutes per reamer. The amount of stock left for finish-grinding was 0.025 inch. The reamer blades were shaped, formed, lipped, the back clearance ground by hand, and the blades hardened before being sent to the finish-grinding department.

The object of the grinding fixture is to hold the reamer in a flat plane while grinding the sides and then to swing it into an angular plane while grinding the radius, this angular position being retained during the grinding of the front cutting edge. As will be seen by referring to Fig. 1, the fixture is provided with a base having an inclined pivot or swivel face upon which swivels an arm mounted on a flat plate. A suitable device for holding and positioning the reamer is mounted on the upper end of this arm. The reamer blade is held in the arbor bar by a pin *A* which passes through a hole in the blade, and a collar *B* which is tightened against the rear end of the blade. The arbor *C* slides through the upper bearing of the arm, and is moved in either direction by a small knurled feed-screw *D*, being locked tight by the thumb-screw *E* acting on the split bearing. The arbor can be indexed 180 degrees, and is held in the two positions by the pin *G* riveted to the spring key *F* mounted on top of the mechanism.

The knurled end *H* of the arbor serves as a handle for operating the fixture. A cup- or deep saucer-wheel *J* is mounted on the wheel-arbor and squared off at right angles to the table, with the center of the wheel about ½ inch below the top edge of the reamer. Stops are provided for grinding the straight side and the radii, and for squaring the end. Referring to Fig. 3, stop *K* consists of a pointer on a sliding member and a stationary plate with a scribed line on it. This indicator is employed when positioning the table for grinding the radii. The radii are ground by swinging the cutter-carrying arm on its pivot base. After grinding one corner to the required radius in this way, the table is fed to the left until stopped by the micrometer stop *L*. During this movement of the table, the cutter-holding arm is at right angles to the face of the grinding wheel, as indicated by the dotted lines at *R*, Fig. 1. Adjustable stops *M* and *N*, which are fitted to the baseplates, limit the rotation of the arm carrying the cutter to an angle of 90 degrees. The accurate location of the diamond used for truing the wheel is of great importance. The point of the diamond must be kept in a line which is parallel with the finish-ground edge of the reamer in order to maintain the accuracy of the set-up. As the reamer is swung around to form the radius and into a position for squaring the end, it is tilted into an angular position in such a way that the portion of the edge in contact with the wheel is always parallel with the wheel-base. A peculiar end-mill effect is produced on the web of the reamer which will cut a clean and perfect center. This end-mill effect is due to the pivoting of the cutter-holding arm in a

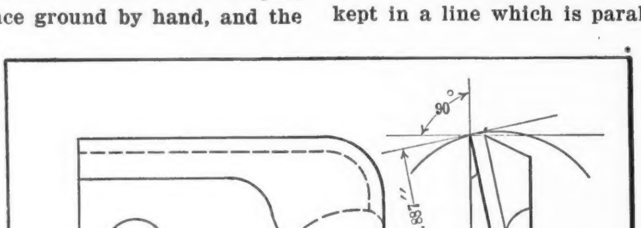


Fig. 2. Special Reamer Blade

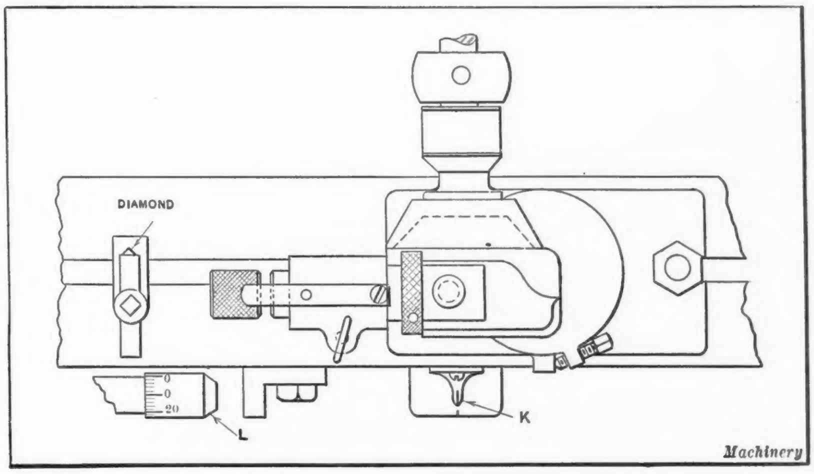


Fig. 3. Plan View of Reamer-grinding Fixture shown in Fig. 1

plane at an angle to that of the wheel-spindle. The best results are obtained with the wheel in the lowered position.

It should be noticed that the exact center of the radius of the cutter and the swivel or pivot center both lie in the same vertical line. By registering the graduation of the handwheel when truing the wheel, and carefully setting the machine to this graduation when finish-grinding, the diameter of the reamer can be held to close limits. When the fixture is in operation, the table is first brought forward so as to take a light trial cut, beginning at the rear end of the reamer and working the table to the left until the pointer lines up with the radius center line of the stationary plate. The table feed is then stopped and the arm carrying the cutter swung through an angle of 90 degrees to form the half-inch radius. The table is again moved to the left until the center stop *L* is reached. The movement of the table is then reversed and brought back to its original position where the cutter is indexed around 180 degrees, or one-half turn. The grinding operations are then repeated.

Hand feed and hand pressure on the arbor, while in both positions, are necessary, as mechanical feeds cannot be used. After finish-grinding, the rear of the side edges are stoned off slightly tapering, the clearance being worked into a negative one. This stoning prevents the rear of the blade from scraping the side of the cavity if slightly out of alignment. The reamer, when ground and stoned as described, produces a very smooth finish, and in the case of high-explosive shells gave the finish required to pass the rigid government inspection. Those familiar with the manufacture of high-explosive shells know that the cavities must be perfectly smooth, as any rough spots would cause friction with the explosive which is set in a rotary motion only by its frictional contact with the walls of the cavity. In order to prevent dangerous premature explosions, it is therefore necessary that exceptional care be used in the manufacture and inspection of munitions of this type.

Allentown, Pa. JOE V. ROMIG

TORCH FOR CUTTING METAL UNDER WATER

A new type of metal-cutting torch designed for operation under water has recently been tried out at the shipbuilding works of the Chantiers du Rhone at Lyons, France. Demonstrations conducted by Eugene Royer, assisted by an American naval attaché and a former representative of the United States Shipping Board, showed that a clean cut can be rapidly made while the metal is submerged. Experiments were made on a piece of armor plate about 11/16 inch thick and 6 11/16 inches long which was entirely submerged in a basin of water. When the blowpipe or torch was plunged into the water the latter immediately began to bubble. The metal finally became severed under the action of the torch, which is said to attain a temperature of about 6500 degrees F. In one minute forty seconds the 11/16-inch steel plate was completely cut through its entire length of 6 11/16 inches.

The lighting of the torch is automatic, and the torch can be readily adjusted to the proper distance from the work. It is claimed that the development of this apparatus will make possible the repairing of ship hulls under water, so that the ships will not have to be put in drydock or careened, and that wrecks or obstructions in shipping channels can be cut up so that they may be readily removed.

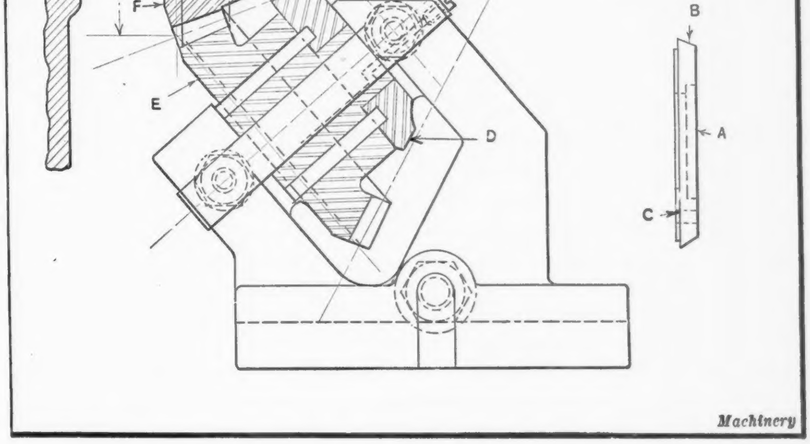
Paris, France W. P. MITCHELL

KNURLING FIXTURE

A large quantity of aluminum castings like the one shown at *A* were required to be knurled on unequally spaced portions of the smoothly finished beveled edge *B*. The knurled portions were to be located in a given position relative to a hole *C*. To meet these requirements, a fixture such as shown in the illustration was made. The knurling tool *D* and the work *A* are mounted on bevel gears *E* and *F*, respectively. This prevents slippage between the work and the knurling tool and enables the knurled surfaces on the tool to be accurately reproduced on the work. Sufficient allowance was made in cutting the bevel gears to provide for feeding the tool in 0.01 inch, which was the depth of knurl required.

The work is held on arbor *G* by a spring washer consisting of members *H*, *J*, and *K*. When the clamp bolt *L* is released, the halves of member *J* are separated sufficiently to pass over the head of bolt *L*, by means of springs *P* shown in the view to the right.

Waynesboro, Pa. D. A. NEVIN

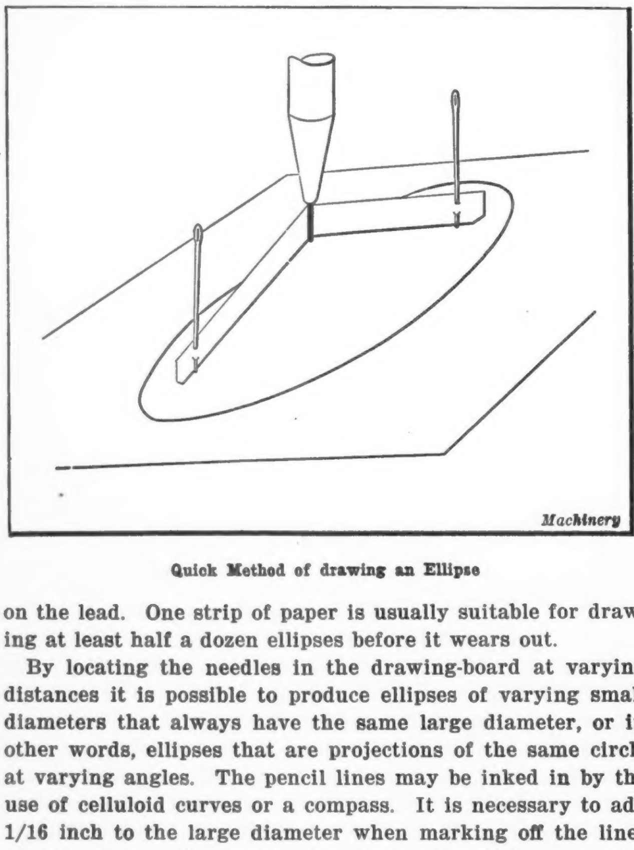


Fixture for performing a Special Knurling Operation on Work A

METHOD OF DRAWING AN ELLIPSE

When it is necessary to draw ellipses quickly, the writer employs a modification of the well-known "string-and-pin" method. With the modified or improved method, the string is replaced by a strip of vellum or bond tracing paper 5/16 inch wide. Two sewing needles are used for pivots, as the needles have finer points and a smoother finish than ordinary pins. Two crosswise pencil marks are made on the paper strip a distance apart equal to the length of the large main diameter of the desired ellipse plus 1/16 inch. The strip of paper is then pierced by the needles on these lines in a "weaving" manner, as shown in the illustration. The ends of the paper strip should extend 1/4 inch beyond the needles.

A thin lead held in a pencil-holder is used for drawing the curve. The lead should protrude a little over 5/16 inch from the holder. By holding the pencil vertical and keeping the paper strip stretched at an even tension, the resulting ellipse will be fairly accurate and even. The paper strip is sufficiently wide to assist in supporting the pencil perpendicular to the paper. As the end of the pencil-holder is wider than the lead, it prevents the paper strip from slipping up on the lead. One strip of paper is usually suitable for drawing at least half a dozen ellipses before it wears out.



Quick Method of drawing an Ellipse

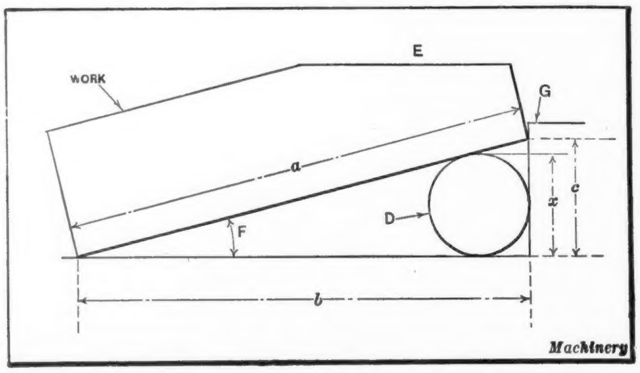
By locating the needles in the drawing-board at varying distances it is possible to produce ellipses of varying small diameters that always have the same large diameter, or in other words, ellipses that are projections of the same circle at varying angles. The pencil lines may be inked in by the use of celluloid curves or a compass. It is necessary to add 1/16 inch to the large diameter when marking off the lines on the paper strip, to compensate for the thickness of the lead. Permanent templets may be produced from thin sheet celluloid by first tracing the ellipse with a steel point in place of the lead, and then carefully cutting the celluloid on the traced outline.

Detroit, Mich. A. L. VARGHA

SETTING WORK AT AN ANGLE BY USE OF DRILL ROD

The writer has found that drill rod provides a simple means of setting up work at an angle for testing or grinding. The accompanying illustration shows graphically the method of using the drill rod. It is, of course, necessary that the opposite sides of the work be straight and parallel, as otherwise some deviation from the proper angle will result.

Referring to the diagram, E represents the surface of the work to be ground. The lower edge rests on the magnetic chuck, and the other end is supported by the drill rod or plug D. Both the work and the drill rod are in contact with the straight edge of the chuck, or a ground parallel G.



Method of setting Work at an Angle by Use of Drill Rod

The following is a simple rule for finding the proper diameter of drill rod to use: Having the angle F given, multiply the dimension a by the cosine of the angle to determine dimension b, and multiply a by the sine of the angle to determine c. Deduct b from a and then deduct the remainder from c. The result is x which is the diameter of the drill rod or plug D. Written as a formula,

$$x = c - (a - b)$$

As an example showing the application of the formula, let $F = 5$ degrees, and $a = 2$ inches; then

$$b = a \times \cos 5 \text{ degrees} = 1.992$$

and

$$c = a \times \sin 5 \text{ degrees} = 0.174 \text{ inch}$$

Then

$$a - b = 2 - 1.992 = 0.008$$

and

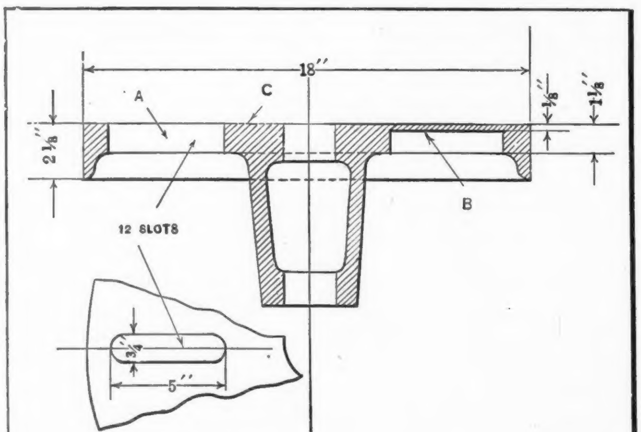
$$x = 0.174 - 0.008 = 0.166 \text{ inch}$$

Bridgeport, Conn. WALTER W. WRIGHT

REDESIGNING SLOTTED CASTING TO FACILITATE MACHINING

The machining of a casting similar in appearance to a slotted faceplate was greatly facilitated by a simple change in the casting as indicated at B in the accompanying illustration. This casting was used on a special machine and was required to be face-turned on the surface C. Ordinarily castings of this kind would be made with the slots extending clear through the flange as indicated at A.

To insure a clean turned face without the edges of the slotted holes being broken or ragged, the foreman ordered the castings made with a filler 1/8 inch thick at the top face of the holes, as indicated at B. This permitted the first, or roughing, cut to be continuous. The fine finishing cut, which followed the roughing operation, was of just sufficient depth to cut through the 1/8-inch filler section, leaving the face of the plate and the edges of the slotted holes clean and smooth.



Casting which was redesigned to facilitate Machining

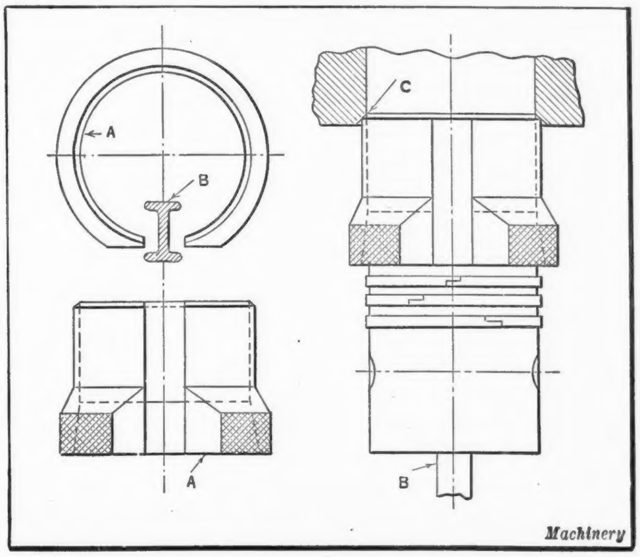
The castings were made in green sand, but better castings could, of course, be made if dry sand cores were used to produce the slot recesses. The stock *B* at the top of the slots should not be less then ⅛ inch in thickness.

Kenosha, Wis. M. E. Duggan

DEVICE FOR ASSEMBLING PISTONS IN CYLINDERS

The ring shown at *A* was developed to facilitate inserting assembled pistons into the cylinder bores of automobile engines. The ring is in the form of a sleeve with a tapered hole in one end which enables the piston-rings to be compressed or forced into position in the piston-grooves before entering the cylinder bore. It will be noted that the ring is split or slotted on one side to allow it to be slipped off the connecting-rod *B* after the piston is in place.

The ring is made heavy at one end to insure sufficient strength at the point where the rings are compressed, while the end which slips into the countersunk bore of the cylinder at *C* is only about 1/16 inch thick. The outside of the large end is knurled to enable the ring to be handled easily, even when covered with oil.



Device used in assembling Pistons in Cylinders

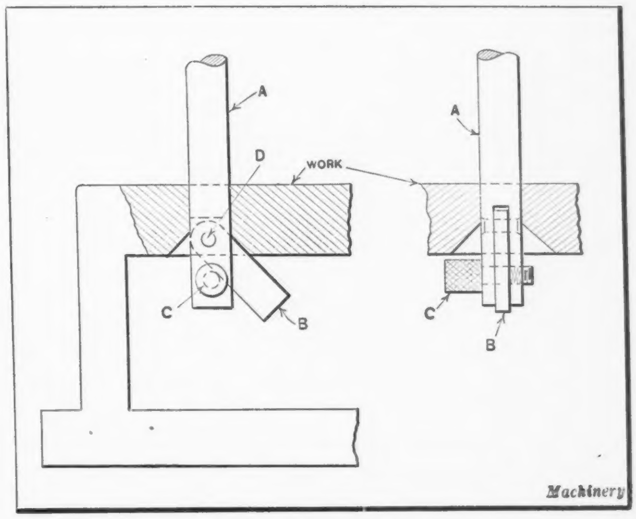
This device is inexpensive, and saves time and unnecessary labor, because all the mechanic has to do is slip the ring over the piston, insert it in the countersink at the bottom of the cylinder in the position indicated in the view at the right, and then push the piston up into position.

Pittsburg, Pa. William Owen

COUNTERSINKING TOOL

It is sometimes necessary or desirable to countersink the inner end of a hole which has been drilled through a cast-iron shell or through work such as that shown in the accompanying illustration. Countersinking operations of this kind can be easily performed by the use of a tool like the one shown in the illustration. This tool consists of a shank *A* made from drill-rod stock, a tool-steel cutter *B*, and a knurled-head screw *C*. The shank of the tool is held in the drilling machine spindle. From the illustration it will be noted that the drill-rod shank is slotted to accommodate the cutter *B* which swivels on a pin *D*.

The cutter is held in the correct angular position for countersinking holes by the knurled-head screw *C*. Screw *C* also serves to prevent the slot in which the cutter is held from spreading when the cut is being taken. When the knurled-head screw is removed, the cutter *B* folds down into the slotted end of shank *A*, thus permitting the tool to be inserted in the hole which is to be countersunk. When the end of the tool projects a sufficient distance from the



Tool for countersinking Inaccessible Holes

inner end of the hole to permit the cutter to be pivoted into the correct cutting position, as shown in the illustration, screw *C* is inserted after which the countersinking operation can be performed by feeding the tool upward. After the hole is countersunk to the required depth, screw *C* is removed to permit the tool to be withdrawn from the hole.

Rosemount, Montreal, Canada Harry Moore

SUPPORTING SHOULDERED WORK ON V-BLOCKS

It is sometimes desirable to place V-blocks under a shaft having two or more shoulders, or sections of different diameters. In order to keep the center line of the work parallel with the surface plate, a parallel pad or series of shims and pads must be put under the V-blocks which are used to support the smaller sections. In the accompanying illustration the pad *P* is employed to bring one of the V-blocks up to the correct height for supporting the section having the smaller diameter. The method of determining the correct height *H* of pad *P* is as follows:

Let a = angle of V-block;
R = radius of large part of work; and
r = radius of small end of work.

With these values known, it is desired to find the height *H* of pad *P*.

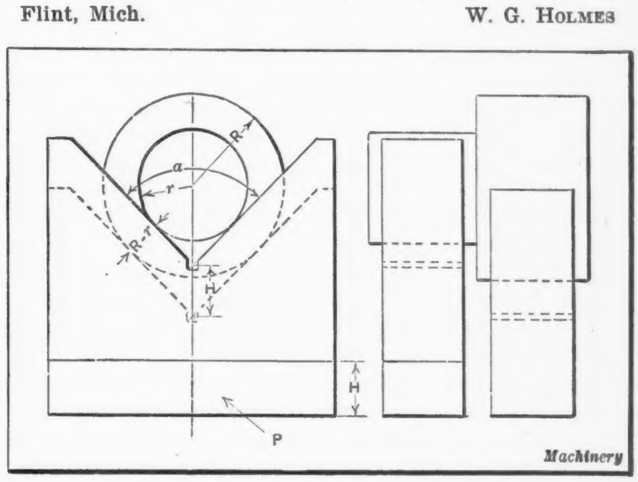
By trigonometry

$$H = (R - r) \operatorname{cosec} \frac{a}{2}$$

Therefore, when the angle a of the V-block is 90 degrees we have

$$H = 1.4142\ (R - r)$$

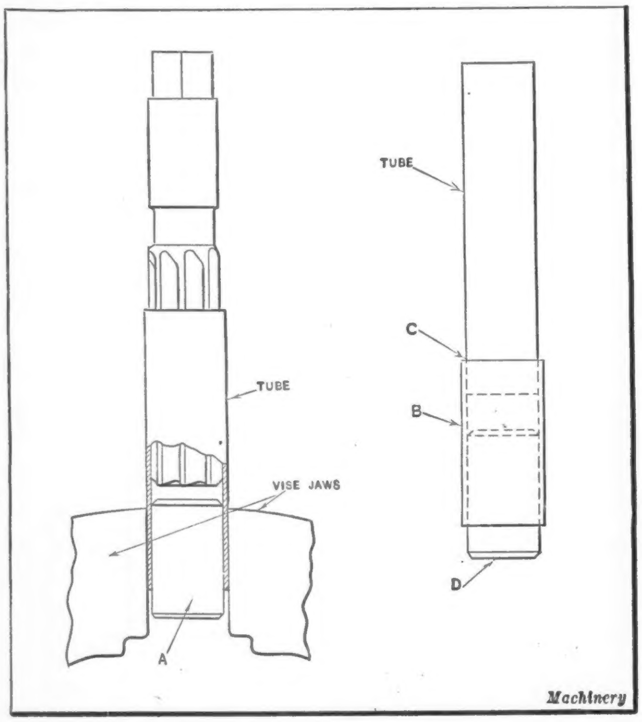
Flint, Mich. W. G. Holmes



Method of using V-blocks to support Shouldered Work

HAND-REAMING THIN TUBING

In making small pump cylinders or other apparatus from thin brass tubing, it is often necessary to ream out the tubing to size with a hand reamer. In performing the reaming operation, difficulty is sometimes encountered in holding the tubing without distorting, cutting, or crushing it. If only a small amount of metal is to be removed, one end of the tube may be gripped by a fine-tooth Stillson wrench, but there is always danger of damaging the work when this method is used. The best way is to drive a brass or iron plug *A* into one end of the tube as shown in the illustration, and then grip this end in the vise, preferably with a V-block between one jaw and the tube. The reamer may then be run in without difficulty. If the tube to be reamed is short, it can be driven into a larger one, as shown in the right-hand view. In some cases the sleeve *B* is split and spread out, after which it is soldered into place at the joint *C*. A plug *D* can then be driven into the extension sleeve *B* and gripped in the vise as shown in the view previously referred to. The extension sleeve should be long enough to



Method of holding Tubing while reaming

allow the reamer to run through the upper tube before bottoming on the plug. After reaming, the sleeve may be released by heating it so as to melt the solder.

Oakland, Cal. H. H. PARKER

REGRINDING THE TEETH IN METAL-SLITTING SAWS

It is not always cheaper to regrind the teeth in metal-slitting saws than it is to buy new saws. There are times, however, when regrinding a saw that is practically worn out may be profitable. It may happen that there is a particular job to be rushed through which requires a certain size saw, and the saw available for this job may be dull or of no further use in its present state. If the time required to obtain a new saw would delay the job considerably, the regrinding method described in this article can often be used to advantage. It may be mentioned that the method was devised by the writer when a circumstance of this nature arose. By referring to Fig. 1, the idea of the arrangement will be readily grasped.

The block *A* on which the saw rests was one of the attachments supplied with the grinding machine. Across the top face of this block there is a groove and on the opposite

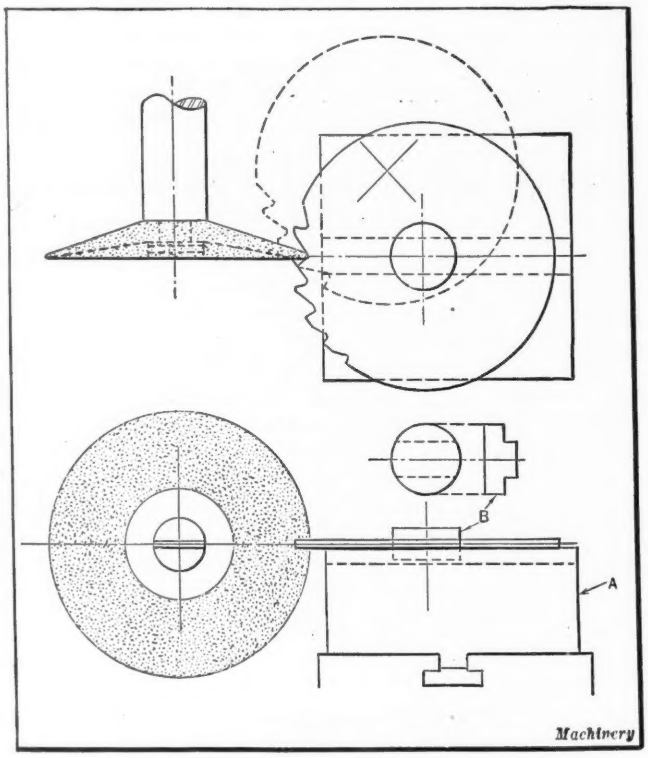


Fig. 1. Method of grinding Metal-slitting Saws

face a tongue. A small stud *B* with a tongue or key across one end, of the proper width to fit the groove in block *A*, is the only part that was required to be made in this particular instance. The saw fits and rotates about stud *B* as a center, and the key permits the saw to be drawn back and forth, to and from the grinding wheel.

The grinding wheel should be of a coarse grade and fairly hard, as the nature of the work tends to wear the wheel away rapidly. The teeth are first notched, the eye being relied upon to determine the proper depth. If the cutting edge is to be radial, a scale or straightedge placed across the grinding wheel will enable the center piece to be properly located. If the teeth are to be under-cut, the table or block can be adjusted to give the angle of under-cut desired.

In grinding the backs of the teeth, the table and block are adjusted to permit the cutter to take the position shown by the dotted lines in the upper view. The angles and general dimensions of the teeth on the most commonly used saws are shown in Fig. 2. Nearly all saws are ground with back clearance, as indicated, and after repeated regrinding the cutter will become slightly under size. By using paper shims the saw can be made to run out of true a sufficient amount to produce the correct width of slot.

Chicago, Ill. CLIFFORD CORNWALL

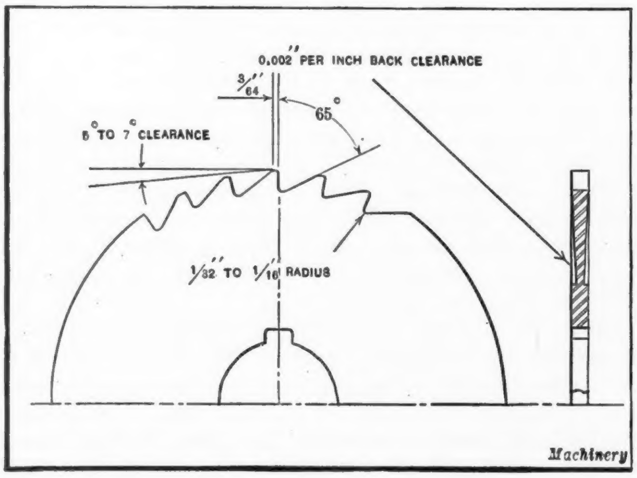


Fig. 2. Diagram showing Clearance Angles usually employed on Slitting Saws

HOW AND WHY

QUESTIONS ON PRACTICAL SUBJECTS OF GENERAL INTEREST

TOOLMAKER'S PROBLEM

R. T.—Please show how to find dimension W, Fig. 1.

A.—First lay out the diagram shown in Fig. 2 from the dimensions given in Fig. 1. Referring to this diagram we have $b = 2$ inches; $a = 3.375$ inches; angle $D = 20$ degrees; and angle $A = 180$ degrees minus 20 degrees = 160 deg. Referring to MACHINERY'S HANDBOOK, page 152, we find that

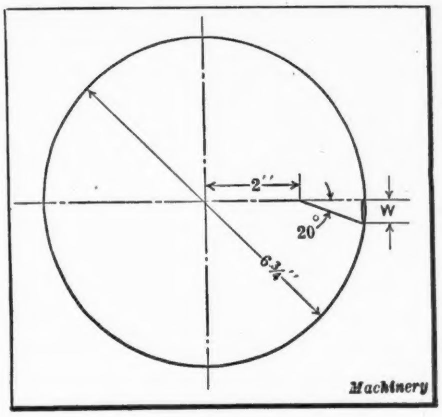


Fig. 1. Toolmaker's Problem

$$\text{Sin } B = \frac{b \times \sin A}{a}$$

$$C = 180 \text{ degrees} - (A + B)$$

Then

$$W = a \times \sin C$$

Substituting the numerical values in these formulas, we have

$$\text{Sin } B = \frac{2 \times 0.34202}{3.375} = 0.20268$$

and

$$B = 11 \text{ degrees } 41 \text{ minutes } 37 \text{ seconds}$$

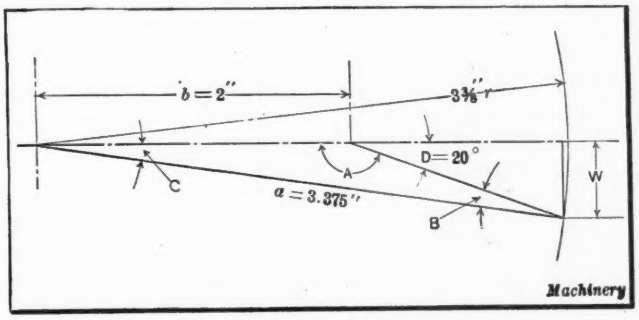


Fig. 2. Diagram used in finding W, Fig. 1

$$C = 180 \text{ deg.} - (160 \text{ deg.} + 11 \text{ deg. } 41 \text{ min. } 37 \text{ sec.})$$
$$C = 8 \text{ deg. } 18 \text{ min. } 23 \text{ sec.}$$

Then

$$W = 3.375 \times 0.14447 = 0.48759 \text{ inch.}$$

ELASTIC LIMIT AND YIELD POINT

H. C. A.—What is the difference, if any, between the elastic limit of steel and its yield point?

A.—The following definitions of the physical properties of materials have been established for use in the testing materials laboratories of the Bureau of Standards:

Elastic limit is the stress which produces a permanent elongation 0.001 per cent of a gage length, as shown by an instrument capable of this degree of precision. This is determined from set readings with an extensometer.

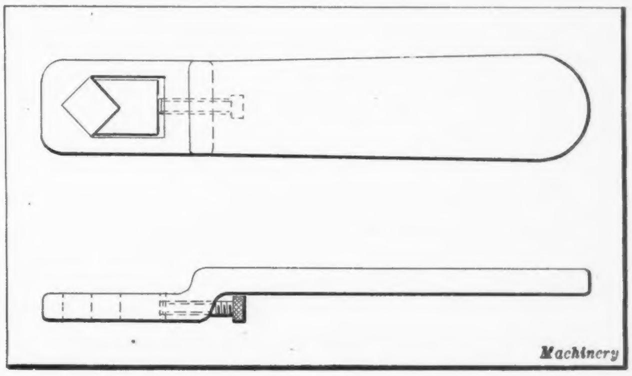
Yield point is the stress at which marked increase in deformation of the specimen occurs without increase in load. This is determined usually by a drop of the testing machine beam or with dividers.

Proportional limit is the stress at which deformations cease to be proportional to the load. This value is determined with an extensometer.

FINISHING WRENCH FORGINGS

S. E.—The writer is having difficulty in attaching abrasive grain to felt polishing wheels for finishing box wrenches, such as shown in the illustration. Patternmakers' glue is used in coating the wheel; this is allowed to dry for a short time and is then stoned down. A second coating is next applied hot, and the wheel immediately rolled in emery. With this method trouble has been experienced from the emery peeling off almost immediately when the wheel is used. The wrenches are made from steel forgings, and are first roughed on a solid emery wheel. Can you give me any information that will assist in overcoming the trouble?

A.—In answering this question it is necessary to know the degree of finish desired. If an ordinary grade of finish is required, after the forgings have been roughed on the solid wheel, use No. 120 alundum for dry-fining. If a better finish than this is required, a second wheel set up with



Adjustable Box Wrench which is finished by polishing

No. 150 alundum may be used. The second wheel should be used with grease in cake form, made from beeswax and suet.

A felt wheel is hardly suitable for a job of this kind; better results will be obtained with a solid bullneck leather wheel. The utmost care is necessary in selecting and preparing the glue. A good grade of blended hide stock glue is recommended. Preheat the wheels so that the hot glue will not become suddenly chilled in setting up the wheel. After the wheels have been rolled in the abrasive, let them dry thoroughly so that the head will become set. This does not mean until they are cold and appear hard, but they should be permitted to set for forty-eight hours before using, in a normal temperature of about 70 degrees F. Drafts near the glue-pot chill the glue and lower its holding efficiency.

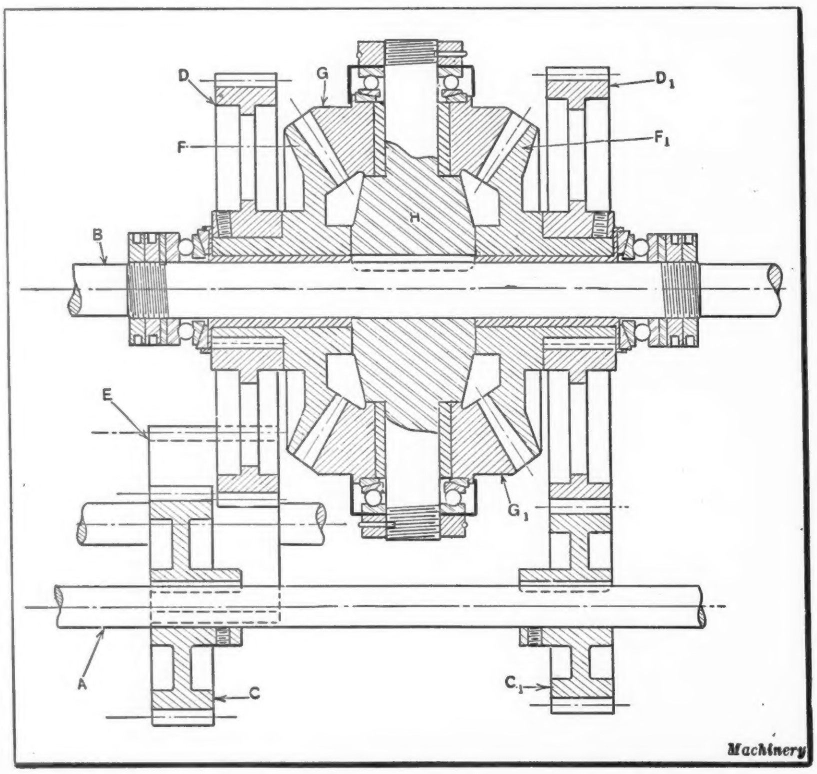
For the highest efficiency in handling a job of the kind mentioned, it is probable that the use of a "compress" polishing wheel made of canvas or leather with a medium density cushion is best. This type of wheel is more expensive than the disk type or the leather-covered wheel, and if such wheels are used, complete instructions as to their preparation can be obtained from the manufacturers of the wheel. With this type of wheel, the wrenches could be finished from the rough without the use of a solid grinding wheel; that is, the wrenches would first be ground with a No. 80 alundum flexible wheel, followed by dry-fining with No. 120, and finishing with No. 150. This will give a high degree of finish, and may be modified somewhat for the ordinary finish, in which case the flexible grinding would be performed with No. 60 alundum and the finishing with No. 120, these two being sufficient. A wheel of medium density cushion would be suitable for covering the entire surfaces of this wrench, if it were not desired to retain the sharp edges of the forging.

SPEED REDUCTION BY DIFFERENTIAL GEARING

By FRANK C. PENNY

A problem that cannot always be easily solved by the machine designer is that of obtaining a speed reduction of large magnitude. Belting may not be suitable, either because it does not give a positive drive from the driving to the driven shaft, or because there is not sufficient room for the pulleys. Lack of room may also prevent the use of chains and sprockets. Spur gear trains often require too many gears, thus introducing high costs and an undue amount of power loss through friction. Worm-gearing is also often objectionable on account of friction losses and the attendant heating. In order to overcome these difficulties, the writer developed, at the plant of the Bridgeport Safety Emery Wheel Co., Bridgeport, Conn., a method of employing differential gearing as a means of obtaining a satisfactory speed reduction mechanism of compact form.

The principle can, of course, be applied in a number of forms and modifications. The form shown in the accompanying illustration is a simple one. The speed reduction is made from the shaft A to the shaft B. As may be seen, the gears C and C_1 are fixed on shaft A. Gear E is merely an idler meshing with gears C and D. Gear D is fixed on the hub of bevel gear F, which is bushed and free to revolve on the shaft B. Gear C_1 meshes directly with gear D_1. Gear D_1 is mounted on the hub of the bevel gear F_1 which is bushed and free to revolve on shaft B, the same as gear F. The crank H is keyed to the shaft B, and on its two arms are mounted the bevel idler gears G and G_1 which are bushed and free to revolve on the arms.



Speed Reduction Mechanism employing Differential Gearing

Now as C and C_1 are keyed to the shaft A, it is evident that they must always turn or rotate in the same direction. It should be noted further that C_1 drives direct to D_1 and that C drives D through the idler gear E. Therefore D and D_1 must revolve in opposite directions. Their speeds are also different, as gear C has more teeth than gear C_1. Gears F and F_1 must, of course, revolve with gears D and D_1 which are mounted on their respective hubs. The bevel gears G and G_1 meshing with both F and F_1 must therefore revolve on their own axes. If F and F_1 should revolve at the same speed but in opposite directions, gears G and G_1 would be stationary with respect to the axis of the shaft B, that is, they would revolve on their own axes, but they would not revolve about shaft B. Now if F and F_1 should revolve at different speeds, G and G_1 must revolve about the axis of the shaft B, and thus revolve shaft B through crank H.

Determining Amount of Speed Reduction

The calculations entering into the design of a speed reduction device of this kind are simple. As in laying out gear trains of any type, it is largely a matter of employing cut-and-try methods. The number of revolutions per minute of shaft B, which is driven by crank H will be one-half the algebraic sum of the number of revolutions per minute of the speeds of the bevel gears F and F_1. In order to make this clear, let it be assumed that a point on the pitch circle of gear F_1 is traveling at a rate of $x + y$ feet per minute, and that gear F is stationary. It is obvious that a point the same distance from the center of shaft B on the axis of G and G_1 will travel at a speed of $\frac{1}{2}(x + y)$ feet per minute.

Now assume that a corresponding point on gear F is traveling at a rate of x feet per minute in the opposite direction or $-x$ feet per minute, and consider gear F_1 to be stationary. The corresponding point on the axis of gears G and G_1 will now travel at a rate of $\frac{1}{2}(-x)$ feet per minute. Next assume that both gears F_1 and F are traveling at their respective speeds of plus $x + y$ and minus x feet per minute. Now adding the speeds of F_1 and F we obtained $x + y - x = y$ feet per minute. Then a speed of one-half y feet per minute equals the speed of the point under consideration on the axis of gears G and G_1.

Now as the pitch diameters of gears F and F_1 are equal and cannot be otherwise, and as these gears mesh with gears G and G_1, it is evident that the number of revolutions per minute can be readily employed to designate the speed. Therefore, the speed of shaft B can be expressed as one-half the algebraic sum of the revolutions per minute of gears F and F_1. The selection of the bevel gears is merely a matter of choosing such sizes as can be used in the available space, and still be of sufficient size to give the necessary tooth strength for the material used and the load imposed. The diameters of gears G and G_1 should, of course, be made as large as permissible so that they will not revolve on the crank H at a higher speed than necessary. In determining the sizes of the spur gears to be used, it is only necessary (not considering the available space) to select such sizes as will give the desired difference in speed between F and F_1, together with a suitable surface speed.

The following example will serve to make clear the procedure followed in laying out or designing a speed reduction device of the type shown in the illustration. We have shaft A running at a speed of -625 revolutions per minute (anti-clockwise), and it is desired to drive shaft B from shaft A so that shaft B will revolve in a clockwise direction at a speed of approximately 3 revolutions per minute. The algebraic sum of the speeds of gears F and F_1 must, therefore, be about $+6$ revolutions per minute. Taking 300 revolutions per minute as an approximate speed for F_1, we may proceed to determine the pitch and size of the gears to be used.

Let it be assumed that we select an 8-pitch gear having a pitch diameter of $7\frac{1}{2}$ inches for D_1 and an 8-pitch gear having a pitch diameter of $3\frac{1}{2}$ inches for gear C_1. These gears will give bevel gear F_1 a speed of $+291.67$ revolutions per minute. The speed of gear F should therefore equal ap-

proximately — 291.67 + 6 or — 285.67 revolutions per minute. Now if gear D has a pitch diameter of 7⅝ inches and gear C has a pitch diameter of 3⅜ inches, gear F will have a speed of approximately — 286.02 revolutions per minute. The difference between the number of revolutions of gears F and F_1 will then equal 5.65 revolutions per minute, and the speed of shaft B will be one-half as great or + 2.82 revolutions per minute.

It is, of course, difficult to obtain an exact speed for shaft B, but by using gears of as fine a pitch as possible without an undue sacrifice of strength, we can obtain very nearly the exact speed desired. The center distance between the two shafts can in some cases be varied, thus increasing the range in speed reduction that may be obtained.

The possibilities of a speed reduction device of this kind is readily apparent to the designer. The speed of the shaft B with respect to shaft A is governed entirely by the speed ratio existing between the gears D and D_1. The speed of shaft A may be as high as the successful operation of the gears will allow, and still by the right combination of gears it may be possible to obtain a very low speed for shaft B. At the same time the whole gear assembly is very compact, and may be installed where other forms of speed reduction mechanisms cannot be used. In order to obtain the best results, all the running parts should, of course, be well oiled and this may be readily accomplished by running the whole assembly in an oil bath or in a case partly filled with oil. Operated under these conditions, the friction loss is very low.

* * *

With the general recovery of trade, South American exchanges may be expected to rise. The Argentine Republic will unquestionably return to gold exchange within a comparatively short time. The fall of exchange usually caused by excessive buying and insufficient selling carries within itself its own remedy. By cutting down the country's buying power it reduces imports and lowers prevailing wages by comparison with outside standards, which should in time foster exports. The reason for the activity of the copper mines in Chile while the mines in the United States were idle, was the low cost of Chilean labor in gold.—Paper by Mr. De St. Phalle, read before the Foreign Trade Convention.

BLANKING AND PERFORATING DIES FOR EXPERIMENTAL PURPOSES

By D. A. NEVIN

The use of so-called "temporary" dies has effected a great saving in many instances in the cost of producing sheet-metal parts. The discarding of expensive blanking and perforating dies during the process of developing and perfecting a new model is unnecessary when temporary dies are used, as dies of the latter type can be employed until the stamp of approval has been placed on the product by the purchasers. The expense of making alterations in the product during its period of development is generally less if separate dies are used for the blanking and perforating operations, as was done in the case of the temporary dies described in this article. This practice allows alteration of the shape of the part without affecting the punch and die for perforating, and the perforating die can be altered without affecting the design of the blanking die.

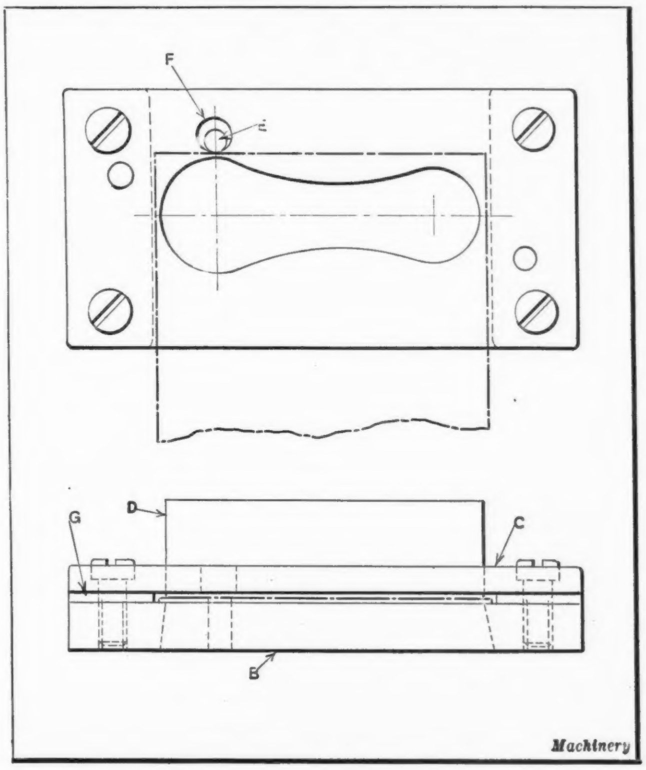


Fig. 1. Temporary Blanking Die

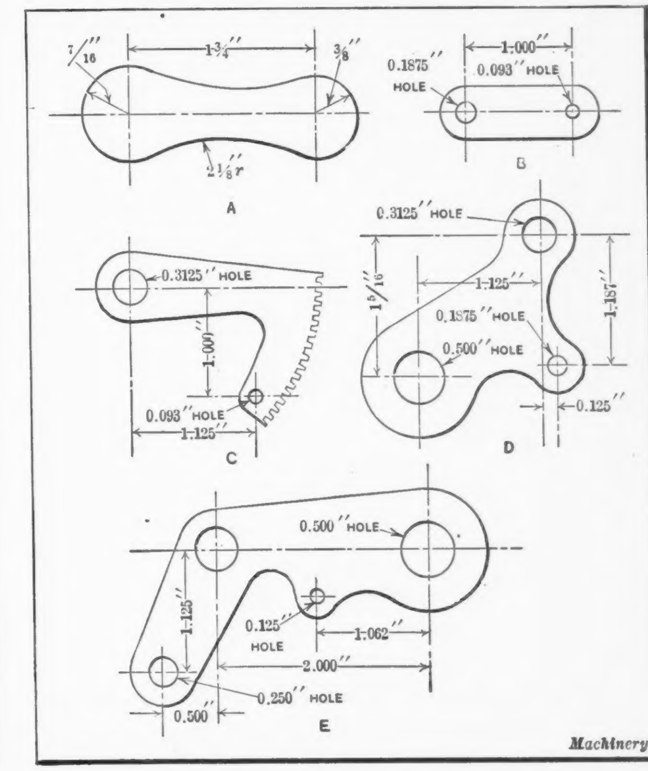


Fig. 2. Parts produced on Temporary Dies

Construction of Blanking Die

The blanking die shown in Fig. 1 is used for blanking the piece shown at A, Fig. 2. This piece is made from 0.050 inch flat steel. Referring to Fig. 1, the die proper B is made from 0.3125-inch tool steel, and the stripper plate C is made somewhat thicker than is the usual practice (0.1875 inch in this case) for the purpose of guiding the punch D, which is ground flat on its top surface. A plain stock stop-pin E is shown just under the sight-hole at F. The spacer guides G allow sufficient clearance to permit the stock to be raised up over the stop-pin when feeding the stock to the next position. By this method of construction a self-contained punch and die is obtained, thus saving the expense of the sub-press design, as well as the cost involved in assembling the punch and die.

It is also an improvement over the old-style of temporary punch and die which did not have the punches guided in the stripper plate and which required the punch to be fastened to the ram and the die to the bolster after alignment of the members. The tool here described, produced very satisfactory work and stood up well during the production of more than 50,000 parts. If properly made and if the requirements

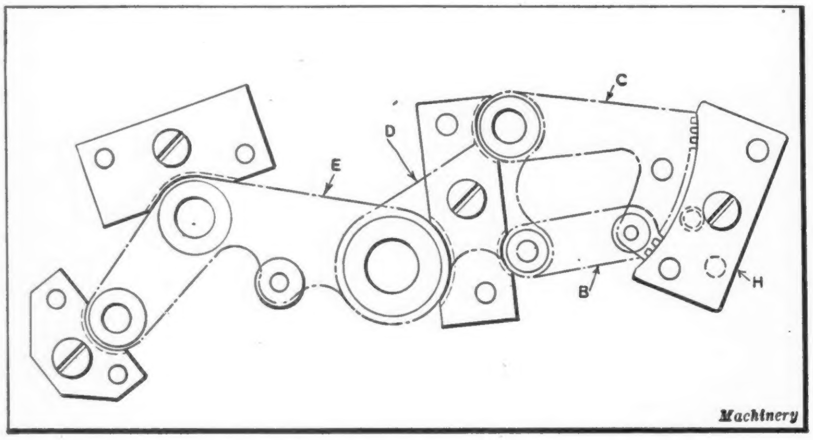


Fig. 3. Perforating Dies of Temporary Type

of production justify the expense, a die of this type can be mounted on a standard sub-press.

Construction of Combination Perforating Dies

Considerable saving in the cost of constructing perforating dies can be obtained by grouping the parts in suitable combinations, provided a large production is not required. In Fig. 2 pieces *B*, *C*, *D*, and *E* are flat parts such as are used in cash registers, adding machines, typewriters, etc. These parts are blanked out in a die similar to that shown in Fig. 1 and are perforated in a separate operation in the combination die shown in Fig. 3, the locating nests being removed or replaced to suit the part being perforated.

In designing a die of this kind a careful study of the parts to be perforated is made, and the parts are grouped or located on the die in such a way that holes of the same size on different parts can be perforated with the same punch. The nest plates for the die shown in Fig. 3 were designed, as far as practicable, to accommodate more than one piece. In laying out this die, the 0.3125-inch holes of parts *C* and *D*, Fig. 2, were matched so that the same punch could be used to perforate both parts. A study of the other parts and the relative sizes of holes showed that the 0.093-inch hole in part *B* checked with the smaller hole in part *C* and that part *B* also required the punching of a hole 0.1875 inch in diameter which was the same size as the smaller hole in part *D*, so that in locating the latter part it was swung around the center of the 0.3125-inch hole until the 0.1875-inch hole was placed 1 inch from the 0.093-inch hole in part *C*, thus providing for perforating both holes in part *B* without adding any more punches.

The remaining part *E* has only a 0.500-inch hole which is common to any of the other parts. This part is located with the 0.500-inch hole matched with the same size hole in part *D*. The number of parts that the punch and die is designed to perforate depends on the production required and the number of parts that can be accommodated without the overlapping of holes in the die-plate. The locating nests should be shown on an assembly of all the nests in order to prevent the screw and dowel holes from overlapping. The die-plate is not hardened, the perforating bushings being a light press fit therein, allowing for their ready removal.

Part *C* or *E*, Fig. 3, may be perforated without removing any of the nests. For perforating part *B*, the nest *H* is removed and exchanged for the nest *J* shown in Fig. 4. In Fig. 4 are also shown the nests *K* for locating part *D*. The perforating punch was mounted in a large sized sub-press in order to allow space for additional parts.

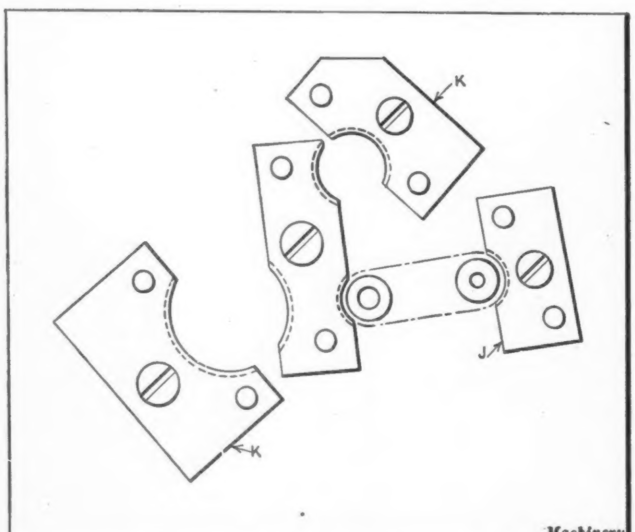


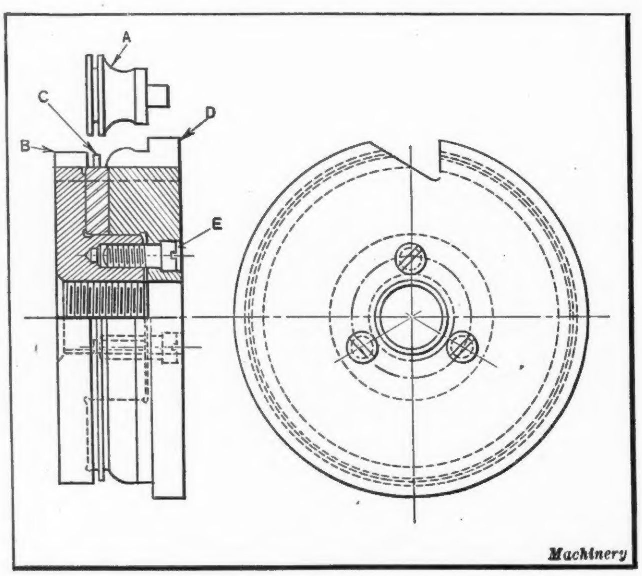
Fig. 4. Diagram showing Method of attaching Locating Nests

* * *

BUILT-UP FORMING TOOL

By EDWARD C. PERRY

A circular forming tool is only as efficient as the weakest point in its outline. When one point fails, the better sections alone cannot produce perfect work. In an ordinary forming tool, the broken point is made serviceable only by grinding away the entire cutting edge. To overcome this apparent waste, the forming tool here illustrated was designed.



Forming Tool of Built-up Construction

The work to be machined is shown at *A*. The difficult feature is a narrow groove 3/64 inch wide by 3/32 inch deep. The thin projection on the forming tool, which cuts this groove, invariably breaks down before any other part, and frequently requires to be replaced. For this reason, the forming tool is divided into three parts *B*, *C*, and *D* as shown. Part *B* is made with a hub which carries part *C* and fits into part *D*. Part *C* is free to revolve on part *B*, except when held in place by the clamping action of three small screws, one of which is shown at *E*.

When the cutting edge of part *C* has worn out, the screws are loosened and the broken down edge raised above the cutting edge of parts *B* and *D* by revolving *C* about its central bearing. The screws are then tightened and the tool ground. The screws *E* are not depended upon to hold the parts in line while the tool is in use; when it is in the machine, the toolpost screw threads into part *B* and draws the latter toward the post, thus clamping the three parts securely in place.

The British Metal-working Industries

From MACHINERY'S Special Correspondent

London, April 15

DESPITE the serious labor disputes that have hampered industry for some time, it is generally agreed that the long period of depression, though by no means over, is now on the mend. There is a steady expansion in iron and steel production, and this indicates a general improvement.

Effect of Engineering Lock-out in Metal-working Industries

The effect of the continued lock-out is felt in varying degrees in the metal-working industries. With demand much below normal, deliveries have been fairly well maintained, but disorganization is becoming more apparent as a whole. Manufacturers who employ a large proportion of skilled workers have naturally suffered more severely than those engaged on work that is done principally by automatic and semi-automatic machinery.

In the automobile and motorcycle industries, which have considerable orders on hand, output has been reduced by 25 per cent; there is a less marked effect in the machine tool field, as this branch has been greatly depressed for a long time, and the output has been very low. Foremen, apprentices, and machine operators have kept the shops open, and some progress has thus far been made with what few orders were in process when the lock-out started.

Machine Tool Trade

The improved prospects in other spheres of engineering are beginning to make themselves felt in the machine tool field. During the past month and before the full effect of the lock-out was felt, home inquiries for new machine tools were numerous, and for the first time in over a year, a moderate amount of business had been transacted in general engineering tools. In the Clyde district, there have been inquiries for special machines to drill and face pipe flanges, and for heavy vertical drilling and boring machines. Radial drilling and tapping machines are being sold to general engineering firms, and prices are generally very low. There is also some demand for boring and turning mills and ordinary light horizontal drilling, boring, and milling machines. Export trade in machine tools is developing, some inquiries having been received from Australia, South Africa, and India.

British products seem generally to be in greater demand on the Continent, but trade in the Far East which recently has been developing has lately fallen off, although to offset this South America is becoming a more active buyer.

Iron and Steel Industries

It has already been mentioned that the iron and steel trade is showing steady progress in output, and British producers have entirely regained the proportion of the home market that went to the Continent a year or so ago. The demand for alloy steels is strong, principally on account of the needs of the automobile industry. Inquiries are being received from Germany, and fairly large quantities of iron are going to that country; France and Italy have also recently become fairly large customers, and substantial business is expected shortly for reconditioning Indian railways.

A Darlington firm is reported to have secured contracts for the construction of eighteen steel bridges for the Siam State Railways; these railways are also asking for quotations for ten locomotives. The Bulgarian Ministry of Commerce is in the market for machinery, tools, and materials, for the exploitation of the state mines in that country. Canadian buyers seek to place orders in the United Kingdom for 1200 tons of 12-inch cast-iron pipes for spring delivery, and a quantity of electric cranes and other loading and unloading equipment for docks is required.

A contract for 400 locomotives has definitely been placed by Rumania with prominent British builders. Not only is this contract among the largest ever placed in this field of engineering, but there is also talk of further purchases of a similar nature being made.

New Gearing Developments

In the field of gearing, two interesting departures from general practice have been made. One is the Hotchkiss-Taylor gear in which the normal rack form is contained in a plane tangent to a cylinder, the basic gear form of the system being a crown wheel, the teeth of which are involutes in a plane normal to the crown wheel. In this tangent rack system, any gear whether cylindrical or conical, can be meshed with any other gear if it is conjugate to the basic tangent rack crown wheel, and if the base circles or normal pitches are equal. A spiral bevel set with intersecting axes, a double helical bevel set with intersecting axes, and a spur gear set have been made. In each of these sets the larger gear is a crown wheel. Bevel gears with non-intersecting axes, and a worm-gear, the axis of which lies in the tangent plane, can also be produced. Great interest is being displayed in the new system.

Another gear development suggested is even more revolutionary. In this case the pinion of a pair of gears, instead of having teeth, is made with an annular space completely filled with rollers that are long enough to extend across the full face of the pinion. The rollers are held in position radially by lips at each side of the pinion, and the teeth of the gear form their own spaces in the pinion by displacing the rollers as they engage the pinion.

Imports and Exports of Machine Tools

The March returns of imports and exports of machine tools, as compared with the month immediately preceding, show a substantial increase in exports—from 990 to 1447 tons, and from £125,082 to £184,776 in total value; these figures are higher than at any time since last August. The general direction of the curves appears to be changing from downward to upward, and seems to bear out the more optimistic feeling as to increasing trade. The value per ton has risen slightly, from £126 to £128. The imports have risen to a less extent—from 268 to 343 tons and from £35,387 to £37,338 in total value. There is a heavy fall in the value per ton of imports, namely, from £132 to £109. Compared with the first three months' exports of last year, the exports for the same period this year are barely half in value, and little difference is noticeable in value per ton.

Prices and Materials

Metal prices have remained steady during the past month, although one or two items, namely finished iron bars and copper, show a tendency to increase in price. Steel-making irons are in greater demand, and the market for semi-finished material remains satisfactory. The demand for foundry iron is low, but preparations are being made for the blowing-in of more furnaces to meet the increased requirements that are expected.

Billings and Spencer Die Milling Machine

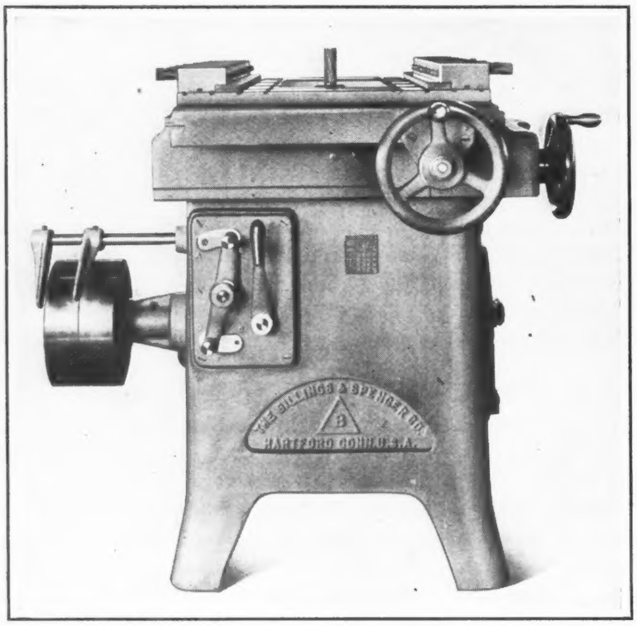


Fig. 1. Machine for milling the Outline of Blanking and Trimming Dies, which has been redesigned by the Billings & Spencer Co.

Fig. 2. End View of Die Milling Machine which clearly shows the Construction of the Horizontal and Transverse Slides

MILLING the irregular outlines of blanking dies and dies for trimming the flash from drop-forgings is frequently a troublesome operation on ordinary vertical milling machines because of the difficulty of observing the work clearly while the operation is in progress. For facilitating such work, the Billings & Spencer Co., Hartford, Conn., is introducing a redesigned milling machine which is shown in the accompanying illustrations. All types of cutting dies for presses may be milled on this machine, with or without clearance draft. The outline of the work is in full view of the operator at all times. The main feature of the machine is the inverted spindle at the center, in relation to which the work is shifted horizontally and transversely at the will of the operator.

This adjustment of the work in relation to the spindle is accomplished by means of two slides, on the top one of which the work is clamped by two parallels adequately supplied with clamping screws. Eight slots on the top slide provide for placing these parallels various distances from the center of the machine so that work varying considerably in size can be handled. The arrangement of the top slide may be clearly seen in Fig. 3. Movement of the slides is obtained through screws actuated by handwheels. Both screws have graduated dials which aid in milling work accurately. The most convenient position for the operator is with one handwheel at his right and the other at his left. A proper sliding fit of the two slides is insured by the use of gibs, and both slides have ample bearing surfaces and narrow guides.

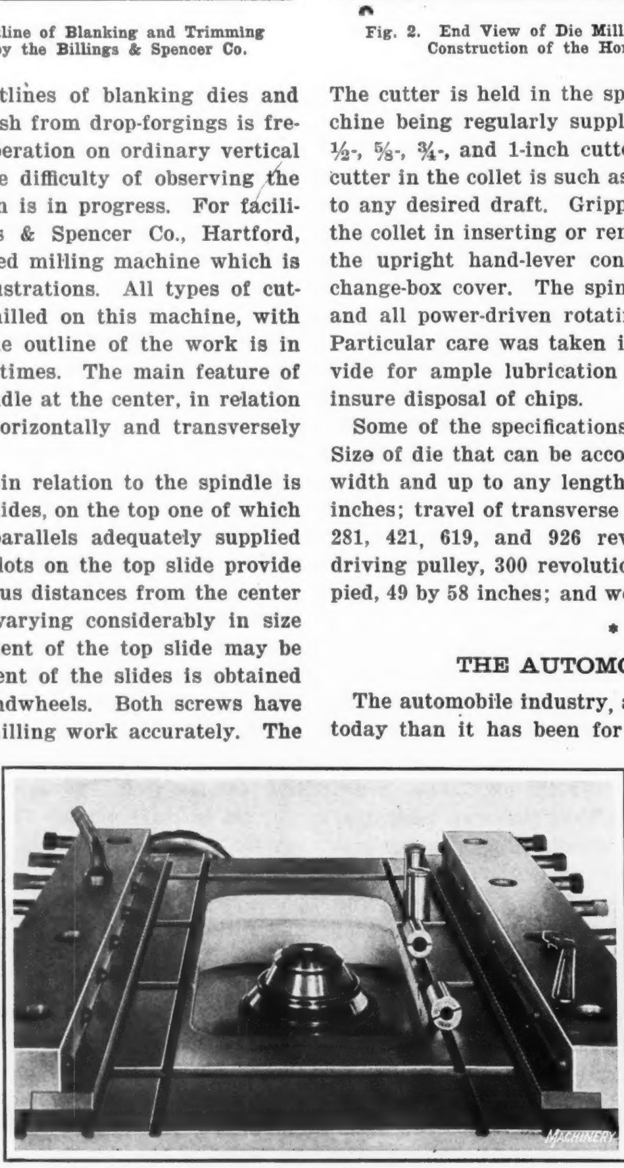


Fig. 3. View looking down on Top Slide and its Clamping Parallels and the Spindle Nose

Four speed changes for the spindle are readily obtained by shifting the levers of a speed-change box. These levers may be seen in Fig. 1. The gears of the speed-change box are driven direct from the constant-speed pulley. The cutter is held in the spindle by a spring collet, the machine being regularly supplied with collets for holding 3/8-, 1/2-, 5/8-, 3/4-, and 1-inch cutters. The method of holding the cutter in the collet is such as to enable the die to be under-cut to any desired draft. Gripping or releasing of the cutter in the collet in inserting or removing it is effected by operating the upright hand-lever conveniently located on the speed-change-box cover. The spindle is mounted in ball bearings, and all power-driven rotating parts are similarly equipped. Particular care was taken in designing the machine to provide for ample lubrication of the spindle bearings and to insure disposal of chips.

Some of the specifications of the machine are as follows: Size of die that can be accommodated, 3 1/2 to 17 1/2 inches in width and up to any length; travel of longitudinal slide, 12 inches; travel of transverse slide; 4 1/4 inches; speed of cutter, 281, 421, 619, and 926 revolutions per minute; speed of driving pulley, 300 revolutions per minute; floor space occupied, 49 by 58 inches; and weight, approximately 2100 pounds.

* * *

THE AUTOMOBILE INDUSTRY

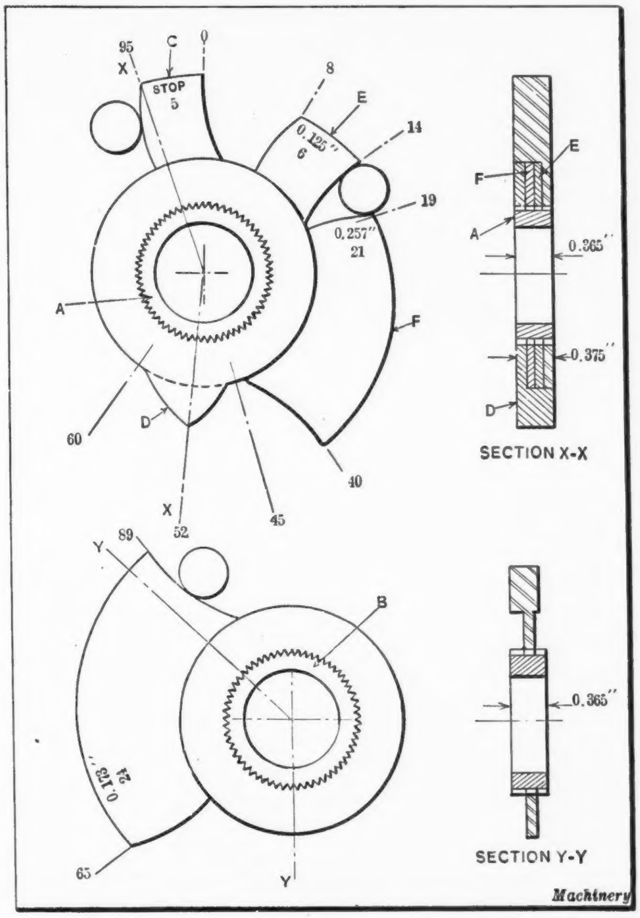
The automobile industry, as a whole, is in a better position today than it has been for the last year and a half. The shops of the leading manufacturers are well occupied but owing to the readjustment that is taking place in the industry, many of the less well known cars find competition very keen, and it is expected that some of these will not survive. The production of passenger cars during the month of April was about equal to that during March—about 153,000 cars being produced each month. The plans for May called for about the same number of cars.

UNIVERSAL CAMS FOR AUTOMATIC SCREW MACHINES

By D. A. NEVIN, Chief Engineer, Watters Corporation, St. Louis, Mo.

A set of adjustable cams for use on a No. 00 Brown & Sharpe screw machine is shown in the accompanying illustration. These cams are designed to permit the use of various combinations of lobes, and to allow the lobes to be set at different positions on the cam hubs. The lead cam may be made up of four lobes, as shown in the upper view, or it may be made up with one, two, or three lobes, according to the requirements of the work. The nature of the work to be performed must, of course, be considered in selecting the lobes which make up a cam. Lobes that are suitable for drilling and turning operations are made interchangeable with those of the cross-slide cam shown in the lower view.

The hubs *A* and *B* of the lead cam and the cross-slide cam have 90-degree teeth of 1/16 inch pitch cut in their periph-



Adjustable Cams for Automatic Screw Machine

eries. The hole in each cam lobe is broached to fit these toothed hubs. The cams are 3/32 inch thick where they come in contact with each other when assembled on a hub, so that the total thickness of four cams is 3/8 inch. The lobes are made of tool steel and are hardened and ground. The cross-sectional view of the lead cam is taken through the stop lobe *C* and the thread lobe *D*. For convenience the amount of throw and the number of hundredths of a complete circle occupied by the cam surface are stamped on the side of each cam lobe. For instance, the notations on lobe *E* show that it has a rise of 0.125 inch and that its cam surface occupies a space equivalent to six hundredths of a complete circle. The thickness of the hub *A* is 0.01 inch less than the combined thickness of the cams, so that the latter are clamped tightly on the camshaft when the clamping nut is tightened. The overlapping sections of the cams are accurately fitted in order to give strength.

The regular locating pin is not used on the No. 00 Brown & Sharpe machine when these cams are employed, as a sufficient grip on the cams is obtained by the clamping nut. If desired, the hub of the cam could be keyed to the camshaft. When combining less than four lobes on the lead cam, washers are used to increase the thickness of the central portion to 3/8 inch. The clamping collars on the camshafts are reduced 1/16 inch in thickness so that the cams will be located centrally. This change does not interfere with the use of the regular cams, which are 1/4 inch thick, as washers can be used to make up the difference in thickness. The cam-roll is made wide enough to allow for the increased thickness of the cams. Only a small variety of thread lobes is required to provide for all threading requirements on the No. 00 machine. The same system may be applied profitably to the No. 0 machine, but on the No. 2 machine the value is not as great.

* * *

INDUSTRIAL CONDITIONS IN FRANCE

By MACHINERY'S Special Correspondent

Paris, May 12

While there are no definite indications that any marked improvement will take place in the industrial situation in the immediate future, the results of the international fairs that have recently been held point to some resumption of industrial activity. The Brussels fair had more than 2000 exhibitors from twenty-four different nations. In 1920 only fourteen nations were represented, and in 1921, twenty nations. The business transacted at the fair appears to be as great as in former years. There were definite indications of reductions in machine tool prices. The machine tools exhibited were noted for simplicity in design and for good workmanship. The Paris fair, which is about to open, also promises to be a great success. The number of exhibitors will be larger than last year, and although it is held after the Brussels fair, it is believed that orders of considerable importance will be placed.

The economic situation in France is improving. Over 5,000,000 acres of land were devastated during the war, and of these nearly 4,000,000 acres have been reclaimed. France will probably be able to raise her entire wheat requirements this year, and as the live stock is increasing steadily, food imports will be still further reduced. Production in the coal mines is increasing, 16,000,000 metric tons of coal being exported in 1921. Pig iron and steel were also exported in large quantities. The increase in the value of the franc is doubtless due to these exports, and also to the efforts of the government to balance the budget.

A ruling has been made in regard to the valuation of imports on which tariff duties are paid ad valorem. The percentage of the ad valorem duties varies according to the country of origin of the imports. When a foreign shipment arrives, the wholesale value in the French market is first determined. Then the value on which the duty is applied is figured as equal to the sum which added to the minimum tariff on that sum would make the price of the goods equal to the wholesale price in the French market.

Take, as an example, a shipment of twist drills having a wholesale value in the French market of 10,000 francs. The value on which the duty would be applied would be a figure so determined that after the minimum tariff had been added to it, the sum would be equal to 10,000 francs. The minimum tariff on drills is 20 per cent, and the value placed on them for tariff purposes would be $\frac{10{,}000 \times 100}{120}$ or 8333 francs.

If the goods came from the United States, the minimum tariff would be applied to this figure, which would be 8333×20 per cent, or 1666 francs. However, if the drills came from Germany, the tariff of 80 per cent would be applied. This would mean a duty of 8333×80 per cent, or 6666 francs.

The importer is required to state the actual value of the goods, and also the sales price in France.

The Machine Tool Industry

FOR the first time in the last eighteen months, it is possible to report a definite improvement in the machine tool industry. There has been—for some months past—a marked improvement in the machine-building industries in general, but the machine tool field has been but slightly affected. Now, however, the records show a rise in the curve of machine tool business above the low level of the past year, and the average of sales of the whole industry has actually increased. While the operation of the shops is far from normal and some are still practically closed, facts clearly denoting improved business should be recorded. Many of the shops entirely closed during part of last year are now operating with small forces. Some of the larger plants that have been operating on extremely conservative schedules have put on increased forces, and others are getting ready to do the same. Some firms that operated at a loss all last year now are able to meet expenses, and some of the leaders in the industry look forward to a steadily improved business from this time on.

Stocks have been reduced in many instances to a point where it is considered advisable to begin building them up again. Compared with 1921, some firms state that their business, so far in 1922, is equal to the entire business of 1921, and in a few instances we are told that the first four months of this year amount to double the business of 1921. The number of firms doing a business more nearly approaching normal is also increasing. At least eight shops are averaging one-half of their capacity business, and, considering the fact that "normal" business in machine tools must be placed considerably below the expanded capacity of the shops, 50 per cent is perhaps not so very far from a normal output.

The activities in the radio field have affected the sale of small automatic screw machines in a marked degree. No automatics of the smaller sizes are available in the second-hand market, and the makers are not able to deliver from stock any longer, but are quoting from four to six weeks deliveries. The sale of small presses has also been favorably influenced by the radio activity.

Prices of machine tools have been reduced in some cases to a point where it is doubtful if even a normal business would make it possible to produce except at a loss, and it is likely that as soon as demand increases, prices in some lines at least will also have to be increased. In this respect the machine tool business will doubtless follow the procedure in the iron and steel business, where prices came down to a low level some months ago, but have since stiffened and have stabilized at a higher level than that to which they first receded. The buying in the machine tool field at present is done almost entirely on price, quality being disregarded in many instances. This condition, too, is likely to change as soon as business in general becomes more active, money is a little easier, and buyers feel they can afford to pay for the best. Nevertheless, even under present conditions, there are buyers who continue to insist upon quality, and are paying for quality in workmanship and materials, which in the long run will prove a wise investment. Some manufacturers have made good use of the time the business depression afforded to so organize their shops and perfect their manufacturing processes that they can maintain high quality without materially increasing the price. But it must not be forgotten that wages in the machine tool industry at present are very nearly double what they were in 1914, and the price of castings still remains practically double that of the pre-war period.

There is a great deal of activity in the development of new machinery. Many new designs have been shown in the mechanical journals during the last few months. Numerous other machines are being designed and developed to be brought out within the next year. These new developments will help stimulate business, as production costs will be brought down by their use. The automobile companies, particularly, are on the lookout for any improvements in the machine tool field, and while very conservative, they have, nevertheless, been among the most active buyers during the last few months. There has also been scattered buying of single machines throughout the entire machine shop field.

LODGE & SHIPLEY AND CARLTON MACHINE TOOL COMPANIES DENY MERGER

In view of the publicity given to a proposed merger in the machine tool field, J. Wallace Carrel, vice-president and general manager of the Lodge & Shipley Machine Tool Co., Cincinnati, Ohio, has authorized the following announcement:

"The Lodge & Shipley Machine Tool Co. is not in any merger or combination. There has been no change in ownership or management. The policy of the company remains the same, and the business will be conducted as it has been in the past."

It has also been announced that the Carlton Machine Tool Co. is not in any merger or combination of machine tool companies and that the ownership and management will remain as in the past.

The Tool Business

The tool shops are better employed at present than they have been for a long time. Most of the tool work comes from the automobile plants. Some die work has also been placed by the radio instrument shops. A growing appreciation of the work of shops specializing in tool design and construction is indicated by the increased buying of tool equipment from such shops by manufacturers who used to do their own tool work.

The demand for accessories in the metal-working field also indicates a general improvement in the business. The sales of abrasive paper and cloth, for example, increased nearly 25 per cent in March over the sales in February, and were almost double the sales of a year ago. The business in grinding wheels is improving, and the sales of wheel-dressers indicate increasing activity in the machine shops. There has been a growing demand for drills, and some of the twist drill manufacturers have increased production. The demand for sheet-metal machinery, including bending and corrugating machines, is good. The electrical tool business is considerably better than the standard machine tool business, and with few exceptions the plants specializing in electrical tools run from 35 to 75 per cent capacity. Some of the old customers have resumed buying, but, on the other hand, it is noted that the orders from the smaller shops have been falling off, doubtless due to financial difficulties. The automobile gear business is booming, and at least one of the shops devoted to the cutting of automobile gears has increased its equipment. The jobbing gear business is improving, but still leaves much to be desired. Were it not for the keen competition and the price-cutting in this field, even the jobbing gear business would show a fair improvement. On the whole, there is now a definite improvement in industry, and while it will be a long time before all adjustments are made to the new conditions, the future is viewed with greater confidence.

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW AMERICAN METAL-WORKING MACHINERY

Colburn Heavy-duty Vertical Boring and Turning Mill

ONE of several innovations in the design of vertical boring and turning mills which have been incorporated in a machine now being introduced to the trade by the Colburn Machine Tool Co., 1038 Ivanhoe Road, Cleveland, Ohio, is a patented single-lever control for all feeds and rapid traverses of the tool-heads and rams. Other important patented features include ratchets on the ram saddles which furnish a means of closely positioning the tool-heads relative to the work, spring counterweights for the rams, a reversing mechanism which provides for cutting threads, and a lubricating system which supplies oil to every bearing surface on the machine subject to wear. The machine is built in six sizes which range from 42 to 84 inches swing, inclusive.

The Colburn single-lever control for feeds and rapid traverse of the heads and rams is mounted under each end of the cross-rail, the two head units being separately controlled. The single-lever of the control is moved along cored openings in the cover plate of the control box. This lever is always operated in the direction of the desired movement, whether feed or rapid traverse. When the lever is moved to engage a feed, all traverse gears are automatically disengaged and vice versa.

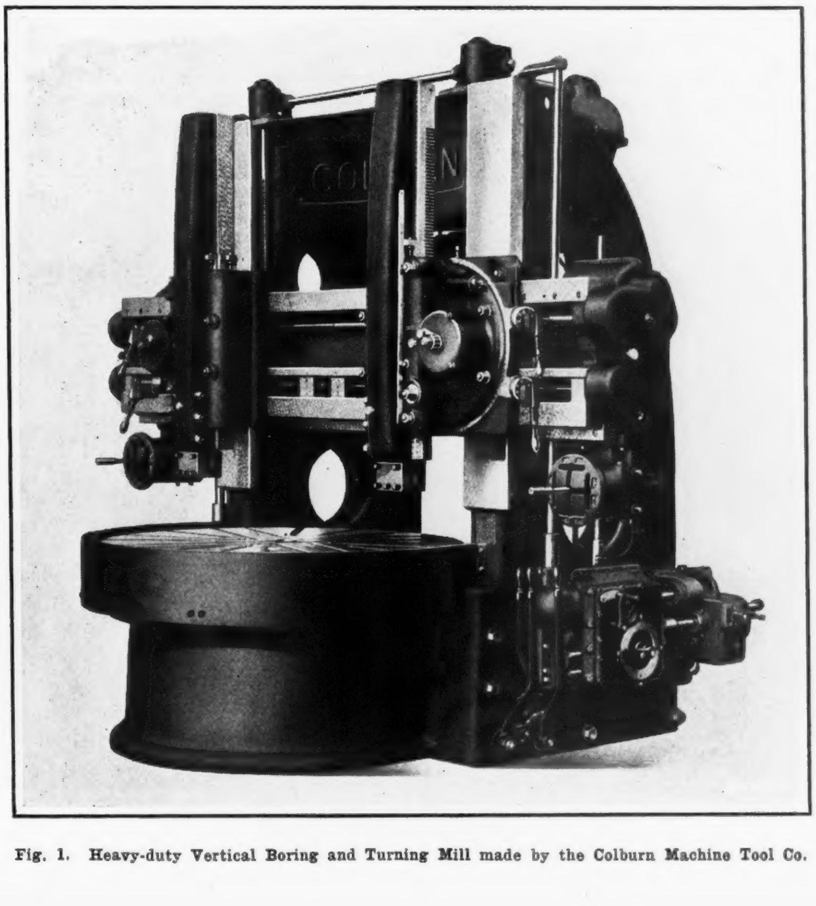


Fig. 1. Heavy-duty Vertical Boring and Turning Mill made by the Colburn Machine Tool Co.

In Fig. 3 the arrows indicate the direction in which the lever is operated to obtain the various feeds and traverse. If it is desired to feed the head at the right-hand end of the cross-rail toward the left, the lever is pushed to the top horizontal slot and then to the left-hand end of this slot. When the head is to be traversed back to the right, the lever is pushed to the extreme right-hand end of the same slot. To obtain vertical movements of the ram, the lever is operated in the vertical slots. In the illustration the lever is shown in the neutral position.

Sixteen feed changes for both horizontal and vertical movements, ranging in geometrical progression from 0.006 to 1 inch per revolution of table, are obtainable through a feed-box on each side of the machine; one feed-box is shown in Fig. 5 with the cover removed. The power rapid traverses allow the heads and rams to be moved at a rate of about 12 feet per minute, and these rapid movements may be secured with the table running or at rest. The rapid traverse mechanism is engaged through the action of a multiple disk clutch in each feed-box.

The cross-rail is raised and lowered by power independently of the table movement through a worm mechanism

and gears in oil-tight cases on top of the housing, power being transmitted through a multiple-disk clutch. Raising or lowering of the cross-rail is accomplished by means of a lever on the inside of the right-hand housing. This lever may be seen in Fig. 2, which shows a rear view of the machine. Ball thrust bearings are furnished at the ends of the cross-feed screw and the vertical feed-worms to eliminate wear and reduce the power required to drive the feeding mechanism. The feed-rods and screws are unusually large in diameter.

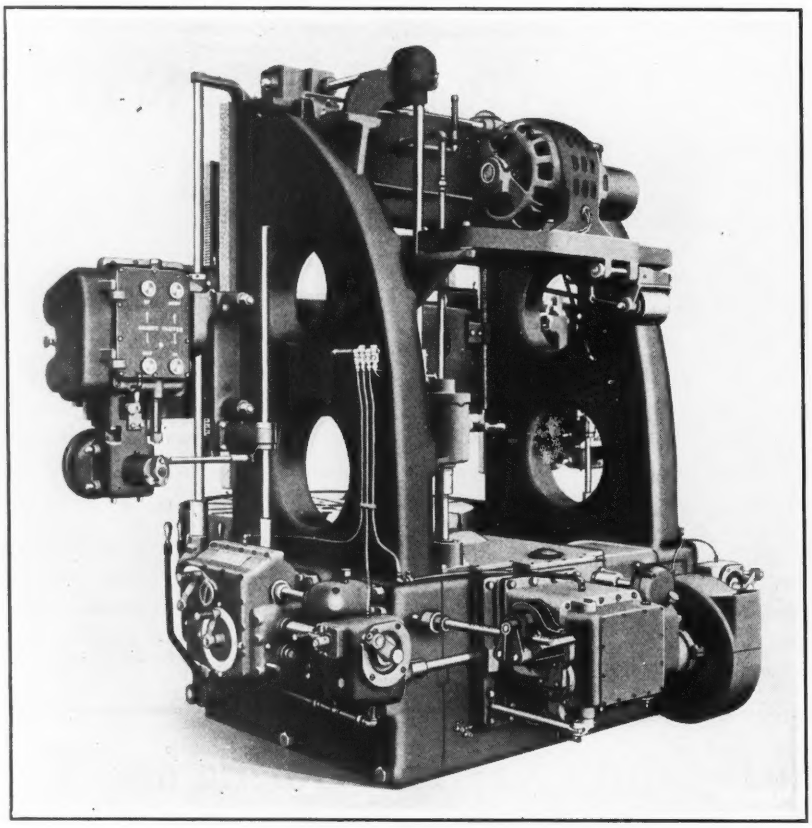


Fig. 2. Rear View of the Colburn Heavy-duty Boring and Turning Mill

The heads are independent in their movements, both as regards direction and rate of feed, and either head may be brought to the center of the cross-rail for boring. The exact central position is determined by a positive hardened stop. Close adjustment of the heads is possible by means of ratchets on the saddles, which have dials graduated to thousandths of an inch. The ratchet, being located on the saddle, is always close to the work, and may be conveniently used while the operator is observing the position of the tool relative to the work. Adjustable taper gibs on the saddles furnish a means of compensating for wear. The rams are also gibbed to the swivel members mounted on the saddles. Bolts are supplied for clamping the swivel members to the saddles when the rams are in the vertical position. A turret head which does not swivel is furnished when desired. This head is always mounted on the right-hand side of the machine and replaces the regular swivel head. The turret has five sides, each of which has tapped holes for attaching box-tools. The turret tilts to an angle of 8 degrees to allow ample clearance for large tools.

The rams have 4 high-carbon steel racks extending their entire length. The rack pinion is made from chrome-nickel steel. The rams may be raised in the swivels sufficiently to allow the bottom of the tool-holders to come flush with the swivels. It is possible to swivel the rams 45 degrees either side of a vertical position, graduations on the swivels indicating the exact setting. The swiveling is accomplished by means of a worm and segment operated through a ratchet lever on the front of each head. The worm and segment of this mechanism also serves as a safety lock to prevent the head from tipping when the clamping bolts are loosened. The rams are counterweighted by a spiral spring enclosed in a steel drum fitted into the front of the heads. This spring can be given any desired tension by operating the ratchet at the front of the drums (see Fig. 1).

Table and Driving Mechanism

The table is a solid casting without cored openings underneath, and has four sets of parallel T-slots planed to accommodate faceplate jaws. Eight radial slots supplement the parallel sets. The table-spindle has a self-centering angular bearing and two vertical bearings which resist all side

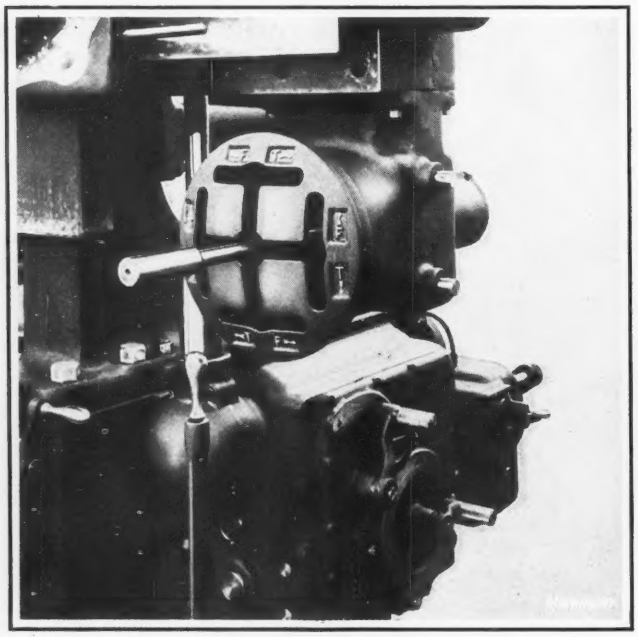


Fig. 3. Close-up View of the Colburn Single-lever Control for Head Feeds and Traverses

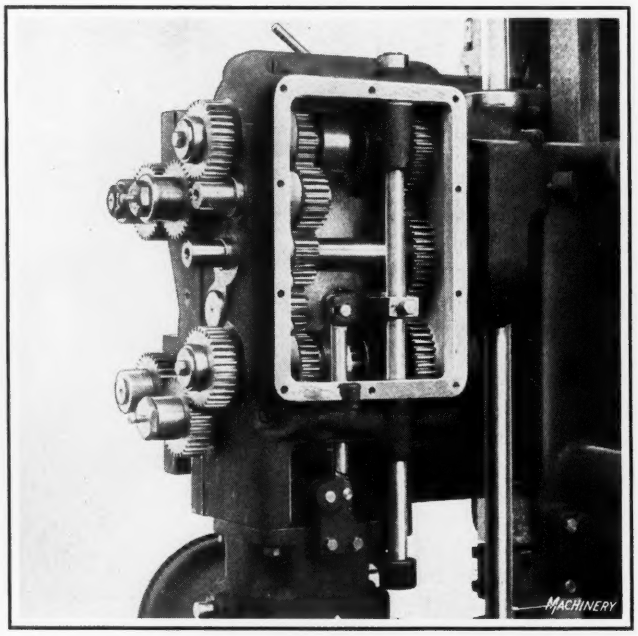


Fig. 4. Feed-clutch Gear-box with Covers removed to show Change-gears and Studs for Threading Gears

strains. A heavy guard protects the operator against injury from the revolving table. Twelve table speeds in geometrical progression are obtainable through sliding gears and positive clutches by shifting two levers at the right-hand side of the machine adjacent to the table. The inside lever operates the gears in a primary speed unit, and the outside lever operates the gears of a secondary speed unit.

The gears are shifted through a patented cam arrangement at the rear of the machine. The secondary speed unit is contained in a box in the main bed, which serves as a reservoir and should be kept supplied with about ten gallons of lubricating oil. The machine may be driven by a motor mounted on a bracket between the housings, through single pulleys and a large friction clutch, or by belt from a lineshaft through a single pulley. Hand-levers on each side of the machine at the front permit convenient starting and stopping. These levers automatically operate a brake, which enables the machine to be stopped instantly at a predetermined point.

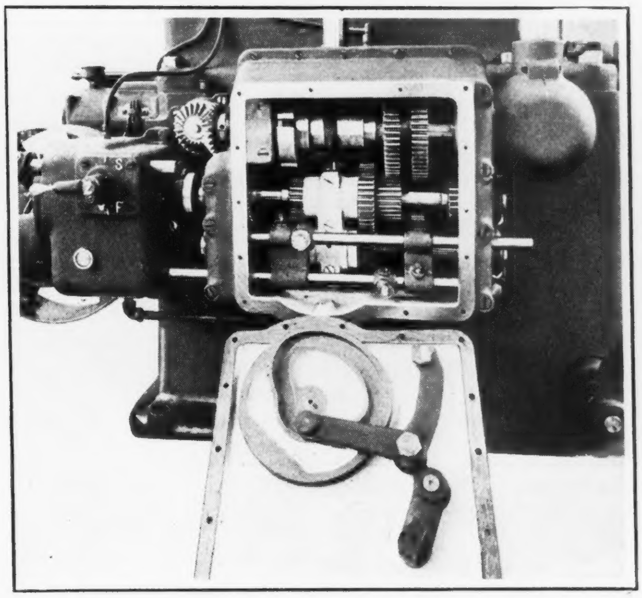


Fig. 5. Feed-multiplying Gear-box on Left-hand Side of Machine

Provisions for Lubricating

Care was taken in designing this machine to provide positive automatic lubrication throughout. The main driving gears and their bearings are lubricated by splash and spray from the oil reservoir previously referred to. Oil is also pumped to a cored reservoir in the top brace of the machine, whence it flows to the feed-boxes, primary table speed unit, table-spindle bearings, and cross-rail elevating mechanism. In each case, the oil passes through sight-feed oilers so that the operator can see whether or not the oil is flowing freely. The feed-clutch gear-boxes at the rear of each end of the cross-rail, one of which is illustrated in Fig. 4, are filled with oil to a certain level. Adequate oiling of the angular and vertical bearings of the table spindle is provided for. Oil is piped from the reservoir in the top brace to the edge of the angular bearing, and is then forced through the vertical bearings back to the reservoir in the bed. Overflow from the angular bearing keeps a supply of oil on the table gear and pinion, and also lubricates the pinion bearing.

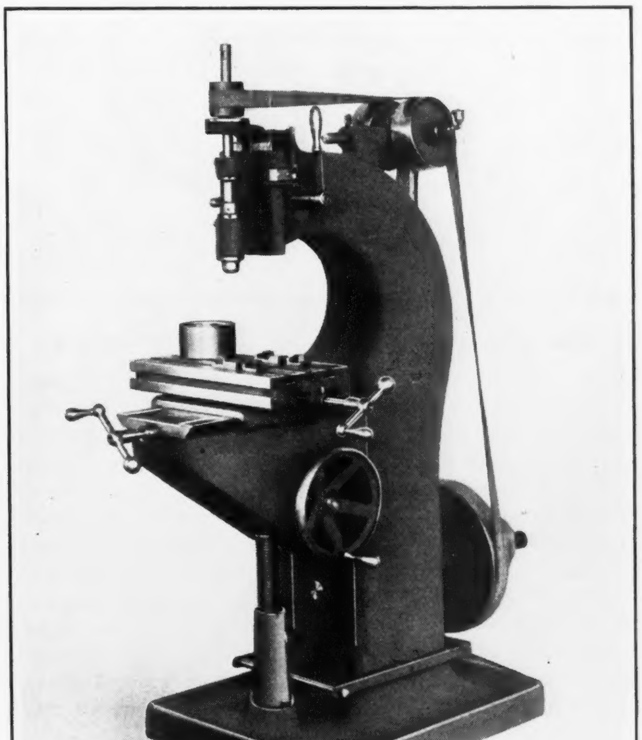
Thread-cutting and Other Attachments

Four, eight, and sixteen threads per inch can be chased without extra equipment, but when extra equipment is provided, standard threads from two to twenty-four per inch, including eleven and a half, can be cut. For cutting different threads, change-gears to suit the desired lead are mounted on the proper studs at the ends of the cross-rail, which may be seen in Fig. 4, and a lever on the feed-box is placed in the proper position. The machine may also be equipped with the following attachments: Revolving spindle center head, grinding spindles, cutting compound outfit, cross-taper and forming attachment, and pulley-crowning attachment.

The safety of the operator received due consideration in the designing of this machine. All moving parts on the ends of the cross-rail are enclosed, and the driving pulley and clutch are guarded. The various units are protected against overload.

BECKER HIGH-SPEED VERTICAL MILLING MACHINE

A demand for a vertical milling machine of the same size as the No. 2 machine built by the Becker Milling Machine Co., 677 Cambridge St., Worcester, Mass., but having higher spindle speeds, has led this concern to bring out the machine here illustrated, on which changes have been made that permit the use of speeds at least 50 per cent higher than on the former machine. It is practical to run the machine at a spindle speed of 6000 revolutions per minute, it being necessary, of course, to pay proper attention to oiling when running at such speed. With the maximum speed of 6000 revolutions per minute, two other speeds of 3240 and 1800 revolutions per minute are obtainable through the use of a three-inch spindle pulley, and three speeds of 3540, 1920, and 1060 revolutions per minute through a five-inch pulley. The necessary countershaft speed is 540 revolutions per minute.



High-speed No. 2 Vertical Milling Machine brought out by the Becker Milling Machine Co.

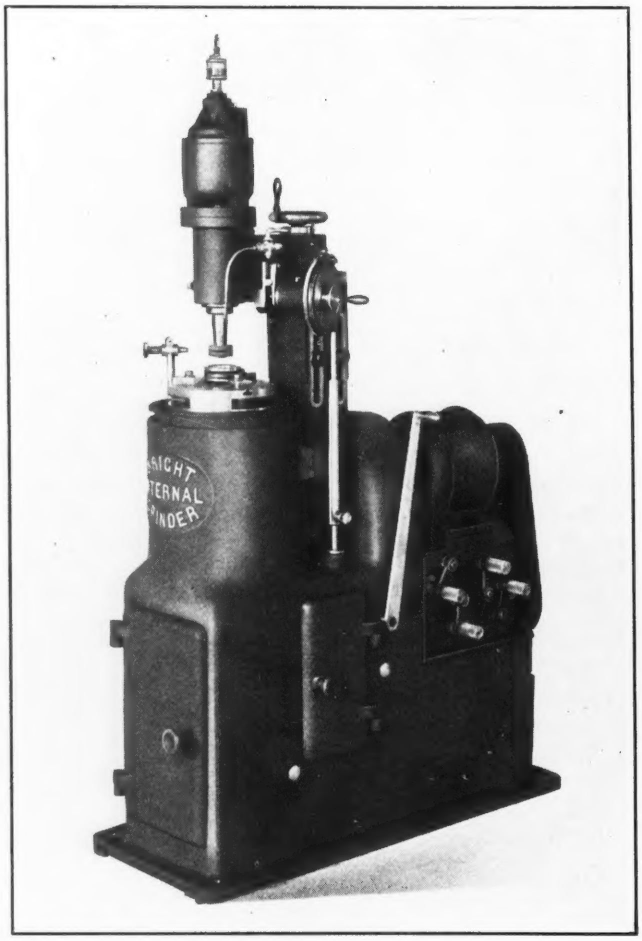
The changing of the spindle pulleys is simple. It is merely necessary to lift the pulley on the machine by hand, away from the sleeve on which it is mounted, and substitute the other pulley. The belt slack is then taken up by means of the adjustable idler-pulley bracket. The machine is equipped with an auxiliary ball bearing to compensate for belt pull. Hardened steel thrust washers are provided for the spindle and the main bearing of this member is made of bronze and has a babbitt lining. The spindle

is ground all over and carefully balanced. The spindle pulley and all rotating collars and nuts are also balanced so as to minimize vibration. Other improvements on the machine consist of a box knee and a steel chip-guard on the knee in front of the carriage, which protects the cross-feed screw.

BRIGHT INTERNAL GRINDING MACHINE

An internal grinding machine, on which the work is held in a chuck mounted at the top of a vertical spindle which both revolves and reciprocates in the same bearing, is being placed on the market by the Garvin Machine Co., Spring and Varick Sts., New York City. This machine is intended for grinding straight round holes in such parts as ball races and automobile transmission gears on a manufacturing basis. It is named after the inventor. The wheel-head swivels on an upright arm to bring the grinding wheel in contact with the surface to be ground and to permit a ready replacement of the work or measurement of the hole. The rated capacity of this machine is for holes up to 4 inches in diameter and 4 inches in length, and work up to 11 inches in swing.

The chuck spindle is supported at the lower end on a ball contained in a pocket at the upper end of the lift bar employed for reciprocating the spindle. The ball bears against hardened steel disks in both the spindle and the lift bar, and the pocket in which it is placed is sufficiently large to permit the ball to revolve freely and thus wear evenly. The spindle is driven through bevel gears from a shaft extending from the speed change-box at the rear of the machine. The gear which drives the spindle runs in a separate bearing and does not touch the spindle. It drives the latter through three sets of flexible keys made of spring steel, which slide in splines as the spindle travels up and down.



Bright Internal Grinding Machine which is manufactured by the Garvin Machine Co.

Driving by means of these keys eliminates any strains on the spindle, and because of this and the ball support, it is claimed that there is no pressure on this member, except that resulting from bringing the grinding wheel in contact with the work. This pressure is said to be negligible, and that a perfect film of oil is always maintained between the contact surface of the spindle and that of its bearing. The length of the spindle stroke is controlled by an adjustable crank arrangement in the base of the machine that is operated by means of a heart-shaped cam. The latter is driven through worm gearing by a second shaft extending from the speed-change box. The cam is designed to give the crank a straight-line action.

There are ten changes of stroke, ranging from 4 to 48 per minute, and five chuck-spindle speeds ranging from 100 to 385 revolutions per minute. The length of stroke may be adjusted while the machine is in operation. The load on the cam and gears is relieved by a counterweight. The chuck-spindle driving and reciprocating mechanisms are driven from a motor mounted on the speed-change box, power being transmitted through a silent chain, friction clutch and the speed-change box. Lubricant is automatically fed to the chuck spindle by a system which ceases to function when the machine is stopped.

The spindle of the grinding wheel is connected to the rotor of a vertical motor on top of the wheel-head. The rotor shaft has only one bearing which is located at its upper end. The lower end of the shaft is connected by a coupling to the grinding wheel spindle. This spindle runs in four ball bearings, which have an adjustment to compensate for wear. An extension for the wheel spindle adapts the machine to deep-hole grinding. The wheel spindle is driven at speeds ranging from 7500 to 12,000 revolutions per minute.

As previously mentioned, the wheel head is swiveled on an upright arm to bring the wheel in contact with the work. The wheel head is roughly set for a given job by means of a clamp bolt, and then fed to the work by rotating a feed screw held in a bracket attached to the housing in which the head arm slides. This feed screw has a total adjustment of 3/4 inch. It contacts with a finished block on the side of the head, to which it is rigidly held to insure accurate feeding of the wheel. The feed screw is automatically advanced by means of a ratchet mechanism. The ratchet wheel has fine teeth about its periphery, each of which causes a 0.0001 inch advancement of the wheel, the wheel being fed forward at each end of the stroke. The height of the head is adjustable a distance of 6 inches by means of a vertical elevating screw operated through a handwheel.

When it is desired to remove or examine a piece of work, the machine is stopped almost instantly by pulling to the front the long lever on the right side. Movement of this lever also raises the wheel-head arm and frees the head from its connection to the feed screw. The head may then be freely swung to the left through an arc of about 45 degrees. At the farthest position, it is held by means of a positive stop in direct line with the truing diamond, in which position the wheel may be conveniently dressed by operating the long lever backward and forward sufficiently to feed it up and down past the diamond. This truing device is always in a fixed position. A spring plunger relieves the head from any shocks in returning it into contact with the feed-screw. Water is pumped to the grinding wheel from a reservoir at the rear end of the housing. The machine is so designed that water or grit cannot be carried to bearings or working parts. The water is returned to the reservoir after serving its purpose. A guard may be raised to surround the chuck.

HORTON DIFFERENTIAL SCROLL CHUCK

Differential gearing incorporated in a wrenchless scroll chuck developed by the E. Horton & Son Co., Windsor Locks, Conn., for use in quantity production work on engine and turret lathes, permits speed of operation and a powerful grip on the work. This chuck may be operated by hand or by

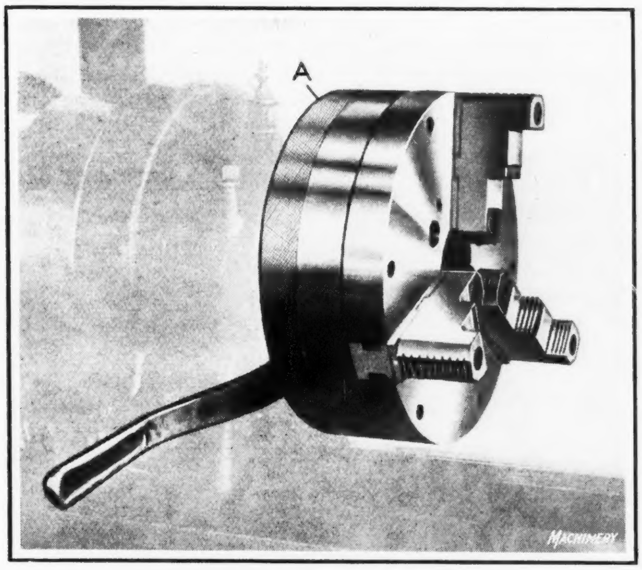


Fig. 1. Differential-geared Scroll Chuck designed by the E. Horton & Son Co.

power transmitted from the machine spindle during the revolution of the spindle before the tool begins to cut the work. The jaws are designed to grip work either on an outside or inside cylindrical surface, and are operated to and from the center of the chuck through five double spur pinions. A large ball bearing insures easy operation. The overhang is no greater than with scroll chucks of the usual design.

To operate the chuck, the knurled handwheel *A* in Fig. 1 is revolved until the jaws close on the work. Then the grip is tightened either by giving a quick push on the handwheel or by starting the machine and exerting a pressure on the lever. In opening the chuck, a quick pull on the handwheel releases the grip, after which the jaws can be run out to clear the work by giving a spin to the handwheel. The construction of the chuck will be understood by referring to Fig. 2. It will be seen that the handwheel carries the five double pinions previously referred to. These pinions mesh with a backing gear pinned to the chuck body and an internal gear on the reverse side of the scroll. The internal gear is different in pitch diameter from the backing gear. Therefore when the handwheel is revolved, the scroll is rotated by a powerful force on account of the differential action due to this difference in pitch diameters. One revolution of the handwheel causes the jaws to move approximately 1/32 inch radially, and opens the chuck 1/16 inch in diameter.

The arrangement for gripping and releasing the chuck by hand is an important feature. By providing for a slight rotation of the backing gear on the pins which hold it to the body, a small lost motion is imparted to the handwheel. This lost motion furnishes a hammer action that multiplies many times on the scroll, the actual pressure applied to the handwheel. The lever is bolted to the machine and carries a friction shoe which may be brought in contact with a surface on the inside of the handwheel. When it is desired to use power for gripping, the lever is employed to retard the handwheel while the chuck revolves. The chuck is now made in a 13-inch size, and 9- and 16-inch sizes are also to be made.

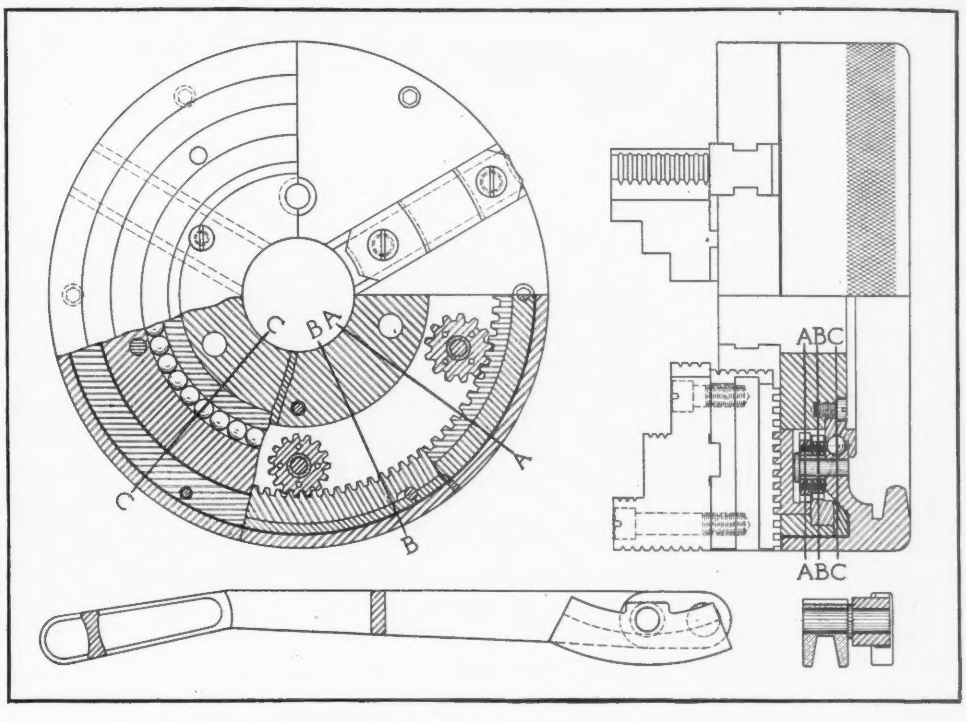


Fig. 2. Construction of the Horton Differential Scroll Chuck

"ETTCO" HIGH-SPEED TAPPING ATTACHMENT

The majority of taps that are broken in use break just after the hole has been tapped and the rotation of the tap has been reversed to withdraw it from the hole. Chips produced when a tap is fed into a hole stick to the wall of the hole, and when the tap is reversed, the heel of the flutes comes in contact with these chips. As these heels are not ground for cutting, the chips become clogged between the wall of the hole and the tap, and produce a strain sufficient to break small-sized taps. With a view to eliminating this source of trouble, the Eastern Tube & Tool Co., Inc., 594 Johnson Ave., Brooklyn, N. Y., has brought out a sensitive high-speed tapping attachment, as shown in Fig. 1, having a friction drive both for feeding and reversing the tap. A cross-sectional view of this attachment is illustrated in Fig. 2. The attachment has a capacity for tapping holes up to 3/16 inch diameter in steel, and up to 1/4 inch diameter in cast iron and brass.

The shank of the tapping attachment is inserted in the spindle of a drilling machine, which may be run at any desired speed. In feeding the attachment, the chuck and the cone *A*, which is leather-faced on its inner and outer conical surfaces, remain stationary until the tap is brought into contact with the part to be tapped. An additional 1/16-inch movement of the machine spindle brings the cast-iron driving cone *B* into contact with the outer leather face of cone *A*. Cone *B* is fastened to the shank of the attachment, and causes cone *A* to drive the chuck spindle in the proper direction for tapping. The friction drive enables the speed of the tap to be regulated by varying the pressure applied to the feed-lever of the machine, which, of course, governs the amount of slippage between cones *A* and *B*.

Any undue resistance results in a complete slippage of the two cones, and so when the bottom of the hole is reached and the tap stops revolving, the operator readily observes that the tapping has been completed and raises the feed-lever of the machine. While this is being done, the chuck and cone *A* remain stationary until the machine spindle has been lifted 1/16 inch, which is sufficient to bring the cast-iron cone *C* into contact with the inner leather face of cone *A*. Cone *C* is driven through gearing from a ring gear on cone *B*, and revolves in the opposite direction to cone *B*. Therefore, the moment that cone *C* is brought into contact with cone *A*, the chuck spindle is revolved in the right direc-

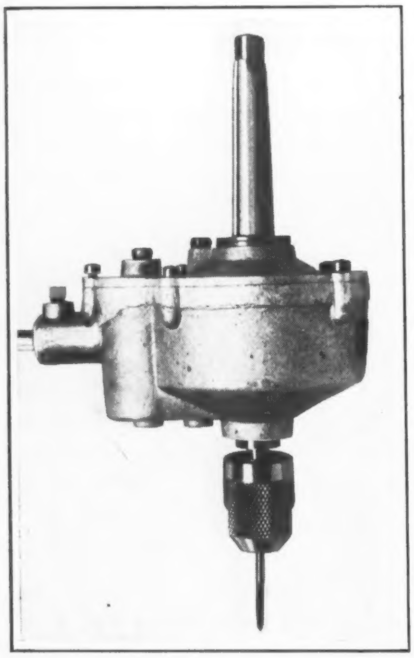


Fig. 1. Tapping Attachment made by the Eastern Tube & Tool Co., Inc.

tion for withdrawing the tap from the hole. In case chips cause the tap to stick during withdrawal, cone *A* will slip on cone *C* as previously mentioned, and the danger of tap breakage is averted.

Power is transmitted from cone *A* to the chuck spindle through an Oldham coupling *D*, which allows cone *A* to float sufficiently to insure a uniform contact at all times with the cast-iron cones. The reverse speed of the chuck spindle is twice the forward speed. The chuck is also manufactured by the Eastern Tube and Tool Co., Inc. It holds the taps by the square end and round shank with equal pressure, and has a slight float to allow a tap to follow the hole correctly. After the leather faces of cone *A* become glazed, the attachment is very sensitive and responds to any slight pressure, the cone slipping whenever the resistance to the tap is greater than normal. By making the housing from aluminum and the gears from a light alloy steel, the weight of the unit has been reduced to about 3¾ pounds. The distance

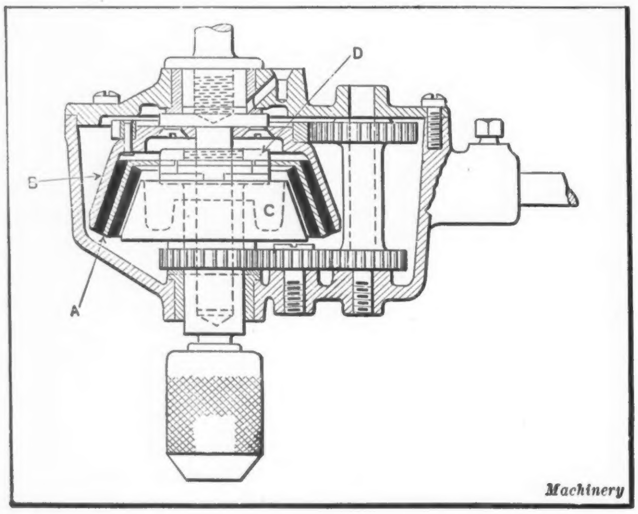


Fig. 2. Cross-sectional View, showing Construction of the "Ettco" Tapping Attachment

from the chuck nose to the end of the machine spindle is 5¼ inches. A rod inserted in a socket of the housing prevents the device from rotating during an operation.

VAN KEUREN MEASURING WIRE SETS

Sets of wires for measuring screw threads, profile gages, and angular surfaces, have been added to the line of precision measuring equipment manufactured by the Van Keuren Co., 362 Cambridge St., Allston, Boston, Mass. From the illustration it will be seen that wires of one size are contained in glass bottles, which protect them against rust and lessen the danger of breakage or loss. The wires are checked by light waves against standards certified by the Bureau of Standards. They are 1⅞ inches in length and lapped the full length to give a long life. Handles or suspension ends are not furnished unless desired.

The wires furnished for thread measurement are known as "best size" wires, that is, they are of such diameter that they theoretically touch on the pitch line of a perfect thread. By using "best size" wires for each pitch of thread, the measurement of the pitch diameter is unaffected by any error of thread angle. This angle may be checked by taking a measurement with the next larger sized wire. Labels on the bottles give the wire diameter in hundred-thousandths inch.

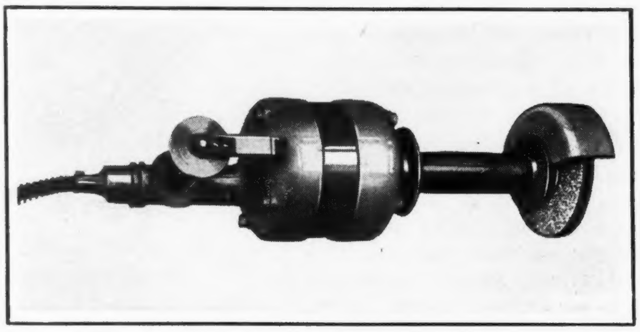
Each label also gives the formula for determining the pitch diameter of a screw with wires of that bottle. To find the pitch diameter, subtract a given constant from the micrometer measurement over the wires in the thread. The set illustrated includes the common sizes of wires for

Set of Measuring Wires introduced to the Trade by the Van Keuren Co.

threads from 6 to 36 pitch. It contains all the wires needed for the measurement of U. S. standard, S. A. E. and National coarse and fine threads, between these pitches. Additional sizes are made ranging from a ½-inch plug to wires 0.00641 inch in diameter for measuring 90-pitch threads.

FORBES & MYERS PORTABLE GRINDER

The motor supplied with the Model 35 portable electric grinder placed on the market by Forbes & Myers, 178 Union St., Worcester, Mass., is insulated with asbestos subjected to a patented treatment which binds its fibers into a tough but flexible mass that prevents the winding of the motor from burning out as a result of overload. The motor is of ¾ horsepower capacity, and resumes its normal speed quickly after having been slowed down by an overload. The bearings are self-lubricating, and may be quickly replaced when worn out. Electric shocks are avoided with this tool by grounding a wire to a water pipe or some other permanent

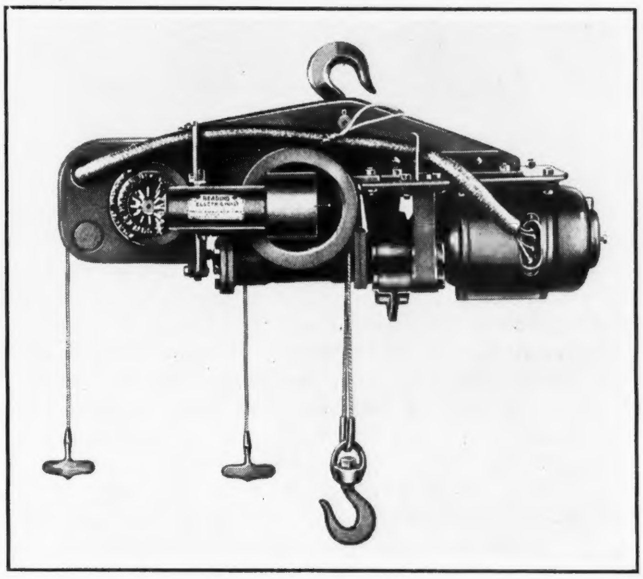


Model 35 Portable Electric Grinder produced by Forbes & Myers

ground. The controlling switch is located in the handle. Wheels 6 inches in diameter by 1 inch thick are standard for this tool, although thicker wheels may be used. The spindle speed is 3600 revolutions per minute.

"EVEREDY" ELECTRIC HOIST

A light-weight quick-speed electric hoist intended to replacing hand hoists in cases where speed is a factor has been added to the line of chain and electric hoists manufactured by the Reading Chain & Block Corporation, Reading, Pa. This hoist is known as the "Everedy" and is made in different sizes having capacities of from 500 pounds to 2 tons. It may be controlled either by a pendant cord or push-button switch, and may be provided either with a plain or geared

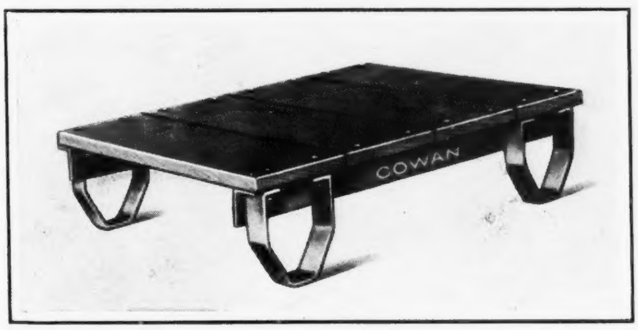


"Everedy" Electric Hoist which is a Product of the Reading Chain and Block Corporation

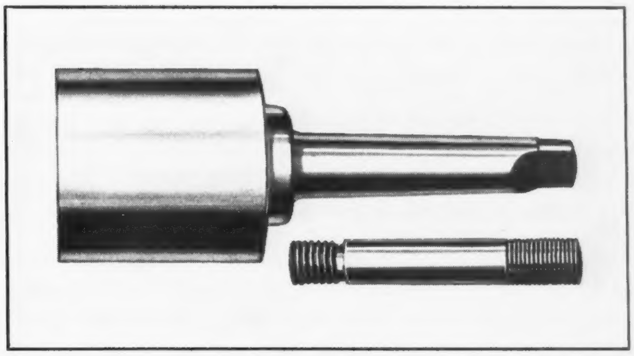
trolley or a hook suspension. The hoist has a motor-and-load brake which takes up its own ware. The rope drums have deep grooves that eliminate overloading and jamming. A special feature of the hoist is a patented positive up-and-down limit stop. All working parts are protected and arranged to run in heavy grease, to insure proper lubrication.

COWAN LIFT TRUCK SKID

For use with hand and electric lift trucks, the Cowan Truck Co., 16 Water St., Holyoke, Mass., has placed on the market a skid consisting of heavy pine planks bolted on two pieces of 2½ by 2 by 3/16-inch angle-iron, to which are attached four malleable iron legs. The construction of the skid is such that the platform cannot spread, sag, buckle or warp. The legs are both riveted and bolted to the angle-irons to insure a rigid connection. The skid is made in lengths from 24 to 80 inches, in widths from 24 to 48 inches, and in heights of 6½, 7½, and 9½ inches. Skids 40 to 80 inches long and 39 to 48 inches wide are also made 11½ inches high.



Hand and Power Lift Truck Skid made by the Cowan Truck Co.



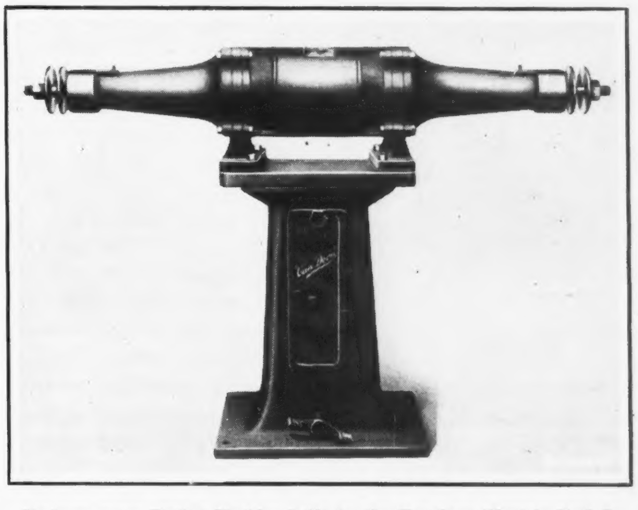
Jarvis Self-opening Stud Setter manufactured by the Geometric Tool Co.

JARVIS SELF-OPENING STUD-SETTER

The Jarvis self-opening stud-setter shown in the accompanying illustration is the latest addition to the line of small tools manufactured by the Geometric Tool Co., New Haven, Conn. This tool is simple in design and easy-working. A quick grip and ready release operate the jaws to and from the stud to be driven in place. This stud setter is regularly made in three sizes: The No. 1½ size has a capacity for studs up to ½ inch in diameter, and is regularly made with either a No. 2 or a 3 Morse taper shank; the No. 2 size has a capacity for studs up to 7/8 inch in diameter, and has a No. 3 or a No. 4 Morse taper shank; and the No. 3 size has a capacity for studs up to 1¼ inches in diameter, and has a No. 4 or a No. 5 Morse taper shank. Taper shanks other than those mentioned may also be furnished. Jaws of different size may be supplied for studs within the capacity of each setter.

VAN DORN HEAVY-DUTY BUFFING MACHINE

A heavy-duty buffing machine designed for large work requiring wheels or brushes twelve inches in diameter or over is the latest addition to the line of electrically driven ma-



Six-horsepower Buffing Machine built by the Van Dorn Electric Tool Co.

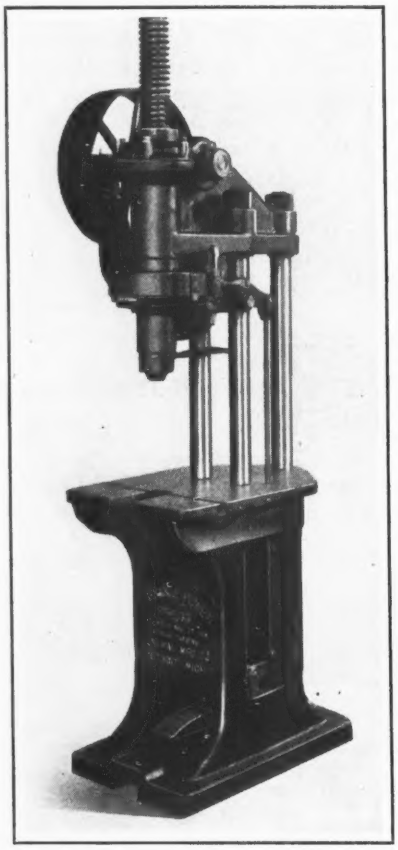
chines manufactured by the Van Dorn Electric Tool Co., Cleveland, Ohio. There are extensions on both ends of the motor so that the brushes are about five feet apart; thus there is ample room for two operators. The buffing-wheel shafts are two inches in diameter inside the arm extensions where they are mounted in ball bearings. These bearings are enclosed in dustproof cages into which grease may be readily injected through four ports on top of the arms. Equalizing couplings are placed between the motor and the wheel shafts to correct any misalignment and thus eliminate vibration.

The motor is designed especially for this machine. It is of the polyphase induction type, and develops six horsepower under normal continuous operation, but has double

that capacity under momentary overloads. The machine can be furnished for operation on two- or three-phase current having from 220 to 440 voltage. The current enters through a conduit hole in the rear of the pedestal, the fuses and switch being enclosed in the latter so that no electrical appliances are exposed. Starting and stopping of the machine is effected through the foot-pedal. Self-ventilation of the motor, which is ordinarily accomplished by a fan inside the motor, can be materially assisted in a dusty atmosphere by connecting the motor housing to a fresh-air supply pipe. This machine weighs approximately 700 pounds.

"FLEXIBLE" POWER PRESS

Flexibility or variation of the power applied on the work is the main feature of a power press developed by the General Mfg. Co., 255 Meldrum Ave., Detroit, Mich. The power may range from a few pounds to eight tons. This press is particularly adapted for straightening operations, pressing bushings in place, and assembling other parts having a press fit. The machine has a stroke of nine inches, and thus can also be used in push-broaching. The table has a fixed height of 30 inches. Three posts extend upward from the table, two of which are under tension and the third under compression.

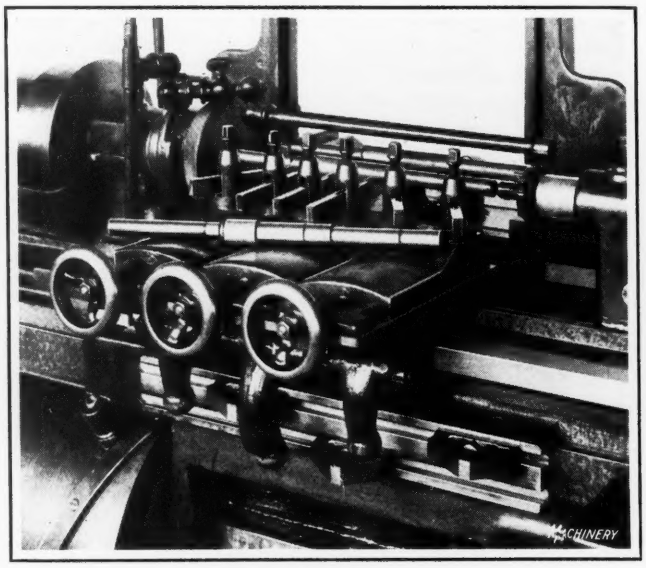

"Flexible" Power Press built by the General Mfg. Co.

The ram has a long-lead Acme thread and runs through a nut four inches long. Power is transmitted from the driving pulley to the ram through worm-gearing. The ram is driven at a constant speed in one direction, the nut turning with it until pressure is applied on the foot-pedal. Operation of this pedal closes an asbestos-lined brake-band on the nut. The ram then passes down through the nut until the pressure is released from the foot-pedal or until the pressure applied by the ram equalizes the pressure on the pedal. The return stroke is obtained through a spring at the top of the ram. The ram is raised immediately after an operation to the position in which the nut revolves about it.

The maximum height between the lower end of ram and table is 12 inches unless otherwise specified. The speed of the ram travel is 150 inches per minute with the pulley running at 300 revolutions per minute. End thrust of the ram is taken by a ball bearing placed between the nut and the main casting of the head.

PRATT & WHITNEY NECKING ATTACHMENT FOR AUTOMATIC LATHE

An automatic lathe with a magazine for feeding cylindrical parts to centers, between which they are held while being machined, was described in December, 1921, MACHINERY, shortly after the machine was developed by the Pratt & Whitney Co., Hartford, Conn. The accompanying illustra-

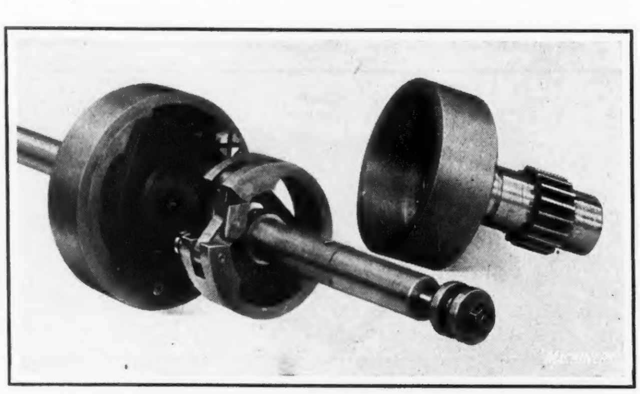

Pratt & Whitney Automatic Lathe fitted with Necking Attachment

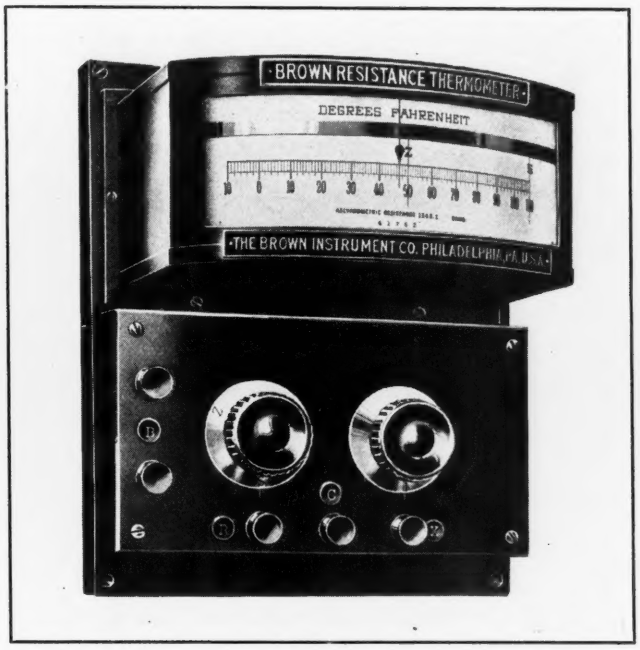
tion shows an attachment which has been brought out for use on this machine. This attachment is designed for squaring shoulders, necking turned surfaces prior to grinding, or for taking other cuts in which a cross-feed can be utilized.

The attachment consists of several carriages which are substituted for the regular carriage. One, two, or three of the special carriages may be clamped in various positions to the front way of the bed. They carry tool-slides and may be provided with multiple toolposts. The cross-slides are actuated through the medium of rolls on arms attached to the carriages. These rolls come in contact with cams mounted on a carrier which is reciprocated longitudinally by the main feed-cam of the machine. The cams on this carrier can be adjusted to provide any sequence of cross movements, and it is possible to move all slides in unison. Adjustment for depth of cut is made on each carriage through its hand-wheel, which has a dial graduated to 0.001 inch. Suitable oil distribution is provided for all working parts. The different members of this equipment may be readily removed from the machine when the regular carriage is to be substituted.

GREAVES-KLUSMAN FRICTION CLUTCH

Geared-head lathes manufactured by the Greaves-Klusman Tool Co., Cincinnati, Ohio, are now equipped with an improved friction clutch in which the clutch ring is expanded on both sides instead of on only one side, as was the case with the clutch provided in the past. The expanders of the new clutch are located at the center of the ring, and apply a direct pressure. Eccentric studs of the levers provide for adjustment to maintain the same leverage at all times. This design eliminates twisting and springing of parts with the resulting wear. The driving hub is made in one piece, with a long bearing on the shaft and a long driving key. This clutch also has a wider face and is larger in diameter for some machine sizes than that previously made.


Greaves-Klusman Friction Clutch



Direct-reading Resistance Thermometer made by Brown Instrument Co.

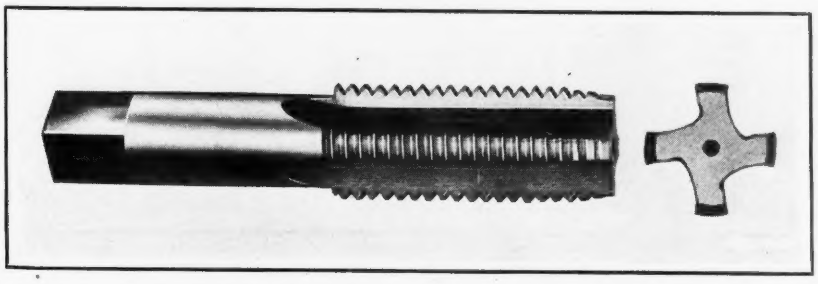
BROWN DIRECT-READING RESISTANCE THERMOMETER

In some heat-treating processes the temperature must be accurately known and maintained within close limits. For example, if the desired temperature is 820 degrees F., the low and high limits may be 750 and 900 degrees F., respectively. The accompanying illustration shows a direct-reading resistance thermometer brought out by the Brown Instrument Co., 4510 Wayne Ave., Philadelphia, Pa., to meet such conditions. The scale of this instrument could be graduated from 750 to 900 degrees F. for the example cited, in which case each division would be equivalent to 1 degree and afford accurate readings. The instrument may be furnished to cover a range of only 25 degrees F. The fundamental principle of the resistance thermometer is based on the well-known physical property of metals (with the exception of special resistance alloys) of change in resistance with change in temperature. This change in resistance can be accurately measured and a scale calibrated in temperature degrees. The bulb or coil of wire which changes in resistance is usually made of nickel for temperatures up to 300 degrees F., and of platinum for higher temperatures up to 1800 degrees F.

The left-hand knob of the instrument is turned to *Z* to check the zero reading, and to *S* to check the instrument with a standard resistance at the top graduation on the scale. The right-hand knob is used for adjusting the voltage. By means of a switch, the instrument can be connected to any number of resistance thermometer bulbs installed in different locations.

BATH "EASY-CUT" GROUND TAPS

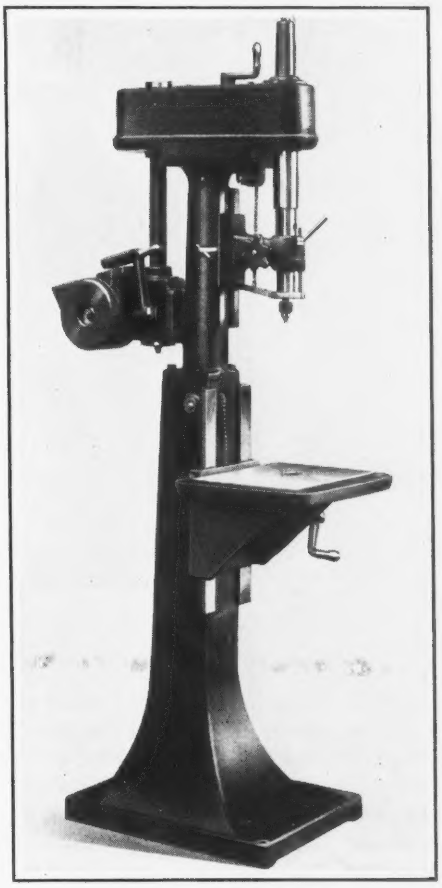
An improvement has been made in the line of "Easy-cut" ground taps manufactured by John Bath & Co., Inc., 8 Grafton St., Worcester, Mass., (described in May, 1921, MACHINERY) by changing the design of the flutes. This new design is known as the "sharpening face" flute. From the illustration it will be seen that each flute has a projecting face having an under-cut clearance that permits the tap to be resharpened without changing its size, until it is worn out. Another advantage is that the cutting face can be ground to any angle or concave to give the desired rake for the kind of material being tapped. The sharpening face is narrow and is the only part of the flute that is finished. The rear side of each flute has a hook for removing chips from the threads of the work when the tap is reversed. This eliminates danger of tooth breakage when the tap is being withdrawn from the hole. The new style flute has a standard width of land and sufficient chip room. Taps are made of both high-speed and carbon steel and may be driven by hand or power.



"Sharpening-face Flute" Tap made by John Bath & Co., Inc.

FOSDICK SENSITIVE DRILLING MACHINE

The principal feature of the new "Superspeed" drilling machine recently placed on the market by the Fosdick Machine Tool Co., Cincinnati, Ohio, is the speed-change arrangement. With this arrangement a single turn of a handle causes the tension on the driving belt to be automatically released and the belt to be shifted first from the larger step of one cone pulley to the next smaller step, and then from the smaller to the next larger step of the second cone pulley. Tension is then automatically applied to the belt. This machine is shown in the accompanying illustration. It is built in both bench and pedestal types in combinations having from one to eight spindles, and has a capacity for driving drills up to 1/4 inch in steel. With the driving pulley running at 1750 revolutions per minute, three spindle speeds of 5700, 8000, and 12,000 revolutions per minute, respectively, are available. However, other speeds may also be provided to meet conditions.



Fosdick "Superspeed" Drilling Machine

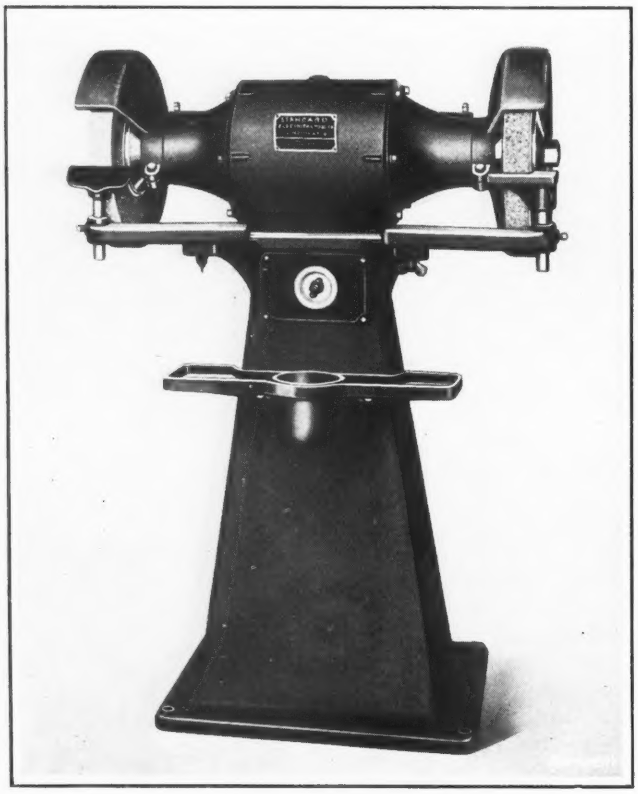
All revolving members are equipped with annular ball bearings and dustproof metal oil containers, the only revolving member exposed being the drill chuck. The drive is through spiral gears. The table on the pedestal machine is of the quick-acting counterbalanced type with a clamping handle at the front, and has a traverse of 10 inches. This table, as well as that of the bench machine, is surrounded with chip and lubricant channels. The head has a vertical traverse of 6 inches, and is counterbalanced to prevent it from dropping when unclamped. The spindle has

a feed of 3 inches, and may be automatically stopped at any point within this range. An adjustable gravity counterbalance may be set to return the spindle automatically.

The position of the feed-lever may be adjusted to suit the convenience of the operator. Opposite the feed-lever is a quick-return handwheel. The belt guard is made of aluminum. Both the belt and shifter may be positioned to receive the driving belt at any angle. A ½-horsepower motor can be mounted on the machine for either a belted or a direct-connected drive. The spindle is provided with a No. 1-A Jacobs drill chuck. The bench-type machine weighs about 225 pounds, and the pedestal type, 465 pounds.

STANDARD ELECTRIC GRINDER

A two-horsepower alternating-current grinding machine, made in both bench and pedestal types for grinding light or

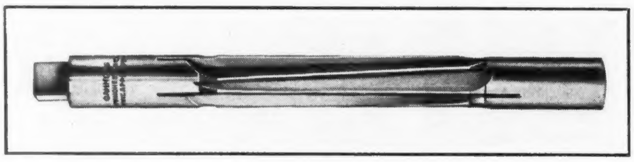


Grinding Machine made by the Standard Electric Tool Co.

heavy work, has recently been added to the line of products manufactured by the Standard Electric Tool Co., Cincinnati, Ohio. The machine is fitted with a tool tray, water pot and tool-rests, as illustrated. The controlling switch is within easy reach of the operator. One coarse and one fine wheel are furnished with each tool, the two wheels being 12 inches in diameter and 1½ inches face width, with a 1-inch bore. The wheels are located a sufficient distance from the body of the motor to facilitate the grinding of large or irregular parts. Both the bench and pedestal types are made for operation on either 110-, 220-, or 440-volt, two- or three-phase, 60-cycle, alternating current.

GAMMONS-HOLMAN REAMER

An expansion hand reamer known as the "Parob" on which each cutting edge is followed and preceded by another which cuts at a different angle relative to the axis of the reamer has been placed on the market by the Gammons-Holman Co., Manchester, Conn. The design of the cutting edges eliminates chatter during an operation and enables holes having a keyway or oil-groove to be reamed satisfactorily. The reamer is expanded by means of a screw-



"Parob" Expansion Hand Reamer manufactured by the Gammons-Holman Co.

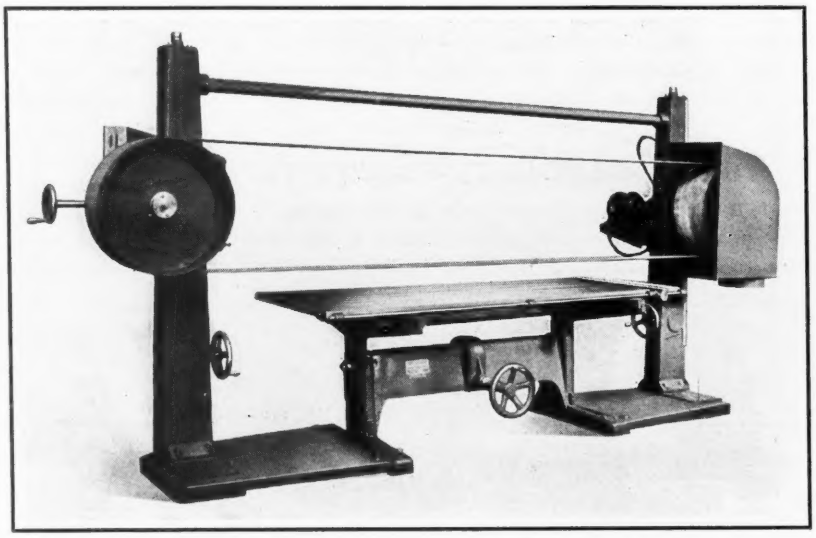
driver, the expanding device being protected against accidental adjustment. It is so located within the pilot that a reamer may be ground on its own centers with the expanding device in place.

A special feature of this tool is an oil-hole that leads from the shank to the inside of the reamer and is connected with slots in the flutes. This provides a convenient means of delivering cutting lubricant to the work. The pilot is amply long for most jobs but pilots of special length may also be furnished. This reamer is particularly adapted for reaming wrist-pin bearings in automobile pistons. It is also made in multiple series for aligning bearings too far apart for standard reamers, or of different diameters. Each section of a multiple-series reamer has a separate adjustment. The reamer is regularly made in sizes from ½ to 1½ inches in diameter.

OLIVER BELT SANDER

The sanding or polishing of wooden pieces required in building large patterns may be conveniently accomplished on a No. 183 self-contained belt sander introduced to the trade by the Oliver Machinery Co., Grand Rapids, Mich. The machine may also be used for polishing metal surfaces. The arms of one pulley are guarded, and the other pulley is entirely enclosed by an exhaust hood. Both pulleys are rubber faced and run on ball bearings. The table top also runs on ball bearings. The table has a vertical adjustment of 14 inches on two uprights connected by a heavy brace, this adjustment being obtained through a screw, gears, and a rack. The horizontal travel of the table is 36 inches, and its working surface is 96 inches long by 32 inches wide.

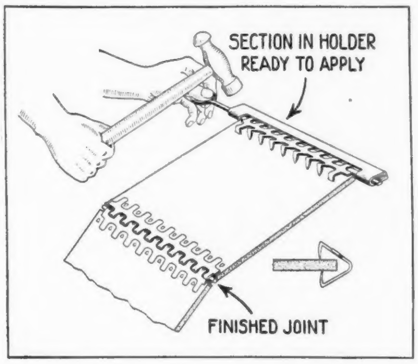
When the machine is motor-driven, a slow-running motor may be direct-connected to the driving shaft, whereas a high-speed motor would be geared to this shaft. The pulley should be run at a speed of about 600 revolutions per minute. Sanding belts about 31 feet long and up to 10 inches in width may be used.



No. 183 Self-contained Belt Sander brought out by the Oliver Machinery Co.

FLEXIBLE STEEL BELT LACING

Flexible steel lacing for tape, fabric, and light leather belts up to 5/32 inch in thickness is being manufactured by the Flexible Steel Lacing Co., 4622 Lexington St., Chicago, Ill. The method of fastening the ends of a belt together by this lacing may be seen in the accompanying illustration. In addition to smoothness of belt running and flexibility of the joint, the advantages that are claimed for this lacing are as follows: A separable connection, the possibility of running either or both sides of the belt in contact with pulleys, quick application, and the necessity of providing only half a joint when a belt must be shortened.

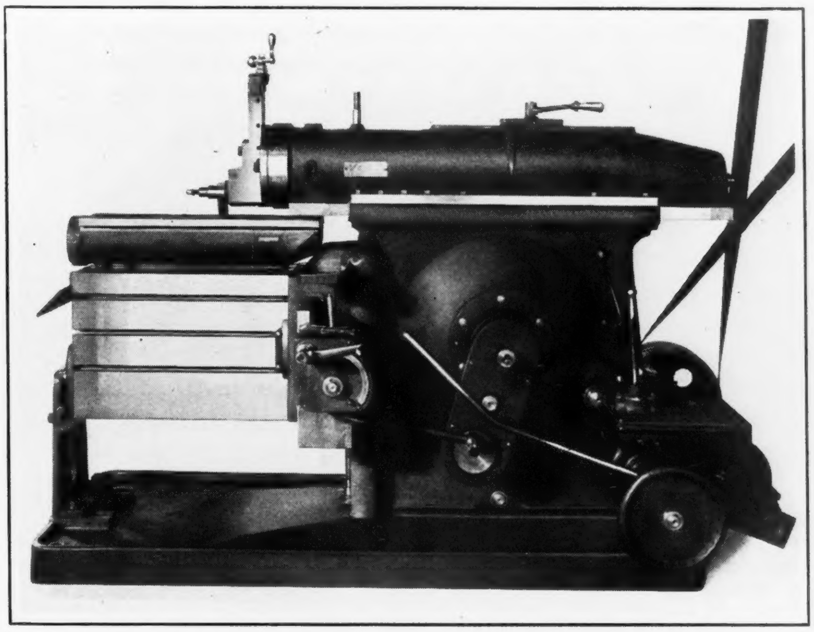


Belt Lacing made by the Flexible Steel Lacing Co.

KELLY HEAVY-DUTY CRANK SHAPER

A shaper designed for the heavy work handled in railroad and forge shops has been placed on the market by the R. A. Kelly Co., Xenia, Ohio. This machine is similar in many respects to a line of shapers made by the same company, which was described in June, 1920, MACHINERY. The new machine has a 32-inch stroke, a vertical table movement of 12½ inches, and a cross traverse of the table of 30 inches. The table is of the swivel type.

The cross-feeding mechanism is simple and entirely enclosed in a box. The direction of the feed is controlled by the straight knurled lever on top of the box, and the amount of feed by the lever on the side of the box. The feeding mechanism cannot be operated during the cutting stroke of the ram. No adjustment is necessary in order to raise or lower the cross-rail, except to loosen and retighten the clamping studs on the cross-rail. The gear-box is designed along the lines of an automobile transmission. It has four speed changes, which are engaged through a ball lever on top of the box. A clutch and brake are controlled by the long lever at the front of the machine. The ram may be brought to a stop at any desired point by the operation of this lever.

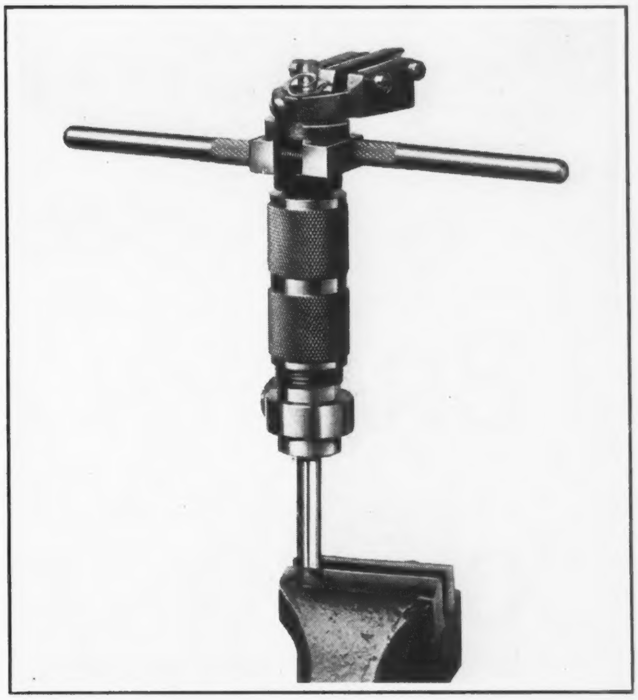


Railroad and Forge Shop Crank Shaper brought out by the R. A. Kelly Co.

When equipped for a motor drive, a bracket is bolted to pads on the back of the shaper for supporting the motor, and a gear is mounted on the driving shaft instead of the pulley. All machines are built so that motor drive may be easily applied, and a gear-box may also be quickly installed on a cone-driven machine. All gears are helical and all slide surfaces are provided with felt wipers. A guard on the table prevents chips from falling on the bearing of the table support. A guard is also placed over the elevating gears, and on this guard are cast directions for elevating and lowering the table. The weight of the machine is about 6500 pounds.

RAMSDELL HAND-VISE "LATHE"

Repairmen in general will be interested in a portable device by means of which studs, set-screws, cap-screws, and special screws, and pins may be produced accurately from bar stock. Coil springs may also be wound to any desired pitch with this device. It is known as the hand-vise "lathe," and is made by the Campbell Mfg. Co., Slater Building, Worcester, Mass. In the illustration it is mounted on a piece of bar stock and provided with a turning tool which is turning down one end of the stock. The tool is fed by turning the knurled member. The body of the device is held in position on the work by a thumb-screw.



Hand-vise "Lathe" placed on the Market by the Campbell Mfg. Co.

In addition to the parts illustrated, the equipment furnished with this device includes knurling tool, spring-winding details, S. A. E. taps and dies, spacers, and centering bushings. The turning tool-holder is so constructed that the die for a threading operation may be fitted in the upper part of the holder and a centering bushing in the lower part. The width of the centering bushing is sufficient to hold the stock central with the die while being threaded, and prevent the cutting of the thread off center. Centering bushings from ¼ to 1 inch in diameter, varying in size by 1/16 inch, are furnished with the set. Bar stock up to 1 inch in diameter can be accommodated, which enables hexagon-head screws up to ⅝ inch to be made. All wearing parts are casehardened.

CHESTERFIELD CUTTING-TOOL METAL

An alloy consisting mainly of nickel, cobalt, and tungsten, which is non-magnetic and non-corrosive, is now being introduced to the trade by the Chesterfield Metal Co., 261 St. Aubin Ave., Detroit, Mich. It is sold in square, flat, and round bars for cutting into tool bits. One feature of this alloy is its extreme hardness, which is retained even when the friction of a cut is so severe as to bring the tool to a red heat. Chesterfield metal derives its hardness from the alloying process by which it is produced, and so cannot be tempered or annealed. This eliminates the danger of burning the cutting edge in dressing a tool.

The metal is cast in molds into assorted standard sizes. It is too hard to cut except by grinding, and so the bars in which it is cast are first nicked with a grinding wheel and then broken to the desired length for use. Tool bits made from the metal may be used in various commercial toolholders or they may be welded to a machine-steel shank. Blades may also be made from the metal for inserted-tooth milling cutters. In a demonstration, a cast-iron disk 15 inches in diameter was rotated at a peripheral speed of about 600 feet per minute, and a cut 1/8 inch deep taken by a tool made from the alloy at a feed of 1/32 inch per revolution. While the cut was being taken the chips came off red-hot and the tool point was also red-hot, but the tool was apparently as good as ever at the end of the cut.

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NEW MACHINERY AND TOOLS NOTES

Portable Drill Stand: A. H. Peterson Mfg. Co., Milwaukee, Wis. A portable stand designed to hold rigidly at any angle, the "Hole Shooter" portable electric drill manufactured by this concern. When placed in a perpendicular position, the equipment is suitable for use as a bench drilling machine, and when placed in a horizontal position, it is especially adapted to grinding or buffing. Bristle wire brushes, rotary taper files, special buffers, and circular saws are also made for use with this drill.

Electric Etching Pencil Outfit: Luma Electric Equipment Co., 405 Spitzer Bldg., Toledo, Ohio. An electric etching outfit consisting of two major units—a magnetic table and a pencil. Its chief uses include etching or writing on hardened steel, demagnetizing steel, annealiing, and soldering. Work which has been placed on a magnetic chuck is demagnetized by simply passing it across the table of the outfit while the current is turned on, and tools or bars may be magnetized in the same way. For annealing, the pencil point is replaced by one made of carbon, and the cord of the pencil is attached to a second connection. The carbon point is also used for soldering.

NUMBER OF EMPLOYES IN THE MACHINE TOOL INDUSTRY

According to a report of the Bureau of Census, there were approximately 61,700 persons engaged in the machine tool industry in 1919. Of this number 2333 were salaried officers, superintendents, and managers, 6186 clerks, etc., (including men and women), and 53,111 wage earners, the latter being an average number. The state of Ohio had 13,855 wage earners (average number) or 26.1 per cent of the total number in the United States. Rhode Island was next in rank with 7169 wage earners, or 13.5 per cent of the total. The accompanying table gives the average number of wage earners in twelve of the most important machine tool building states. This table shows how the total number in each state is divided in regard to the prevailing working hours. The hours for most wage earners in the machine tool industry (39 per cent of the total number) are between 48 and 54 hours per week. About 29 per cent work 48 hours per week, 19 per cent between 54 and 60 hours per week, 10 per cent 54 hours, 2 per cent between 44 and 48 hours, one-half of one per cent 44 hours or less, and one-fifth of one per cent 60 hours per week. The total number of establishments in the United States directly engaged in the production of machine tools during the year 1919 was 403, and the total value of the products, $212,400,000.

AVERAGE NUMBERS OF WAGE EARNERS IN THE MACHINE TOOL INDUSTRY DURING 1919, BY STATES AND BY PREVAILING HOURS OF LABOR PER WEEK

State	Wage Earners, Total Average Number	Per Cent of Total for U. S.	Numbers of Wage Earners according to Prevailing Hours of Labor							Number of Establishments
			44 Hours and less	44 to 48 Hours	48 Hours	48 to 54 Hours	54 Hours	54 to 60 Hours	60 Hours	
Ohio	13,855	26.1	1	169	7926	3241	473	2045	....	102
Rhode Island	7,169	13.5	....	....	....	7065	....	104	....	13
Massachusetts	6,471	12.2	....	....	643	3866	692	1270	....	46
Connecticut	5,472	10.3	13	....	1691	632	2062	1074	....	33
Pennsylvania	3671	6.9	....	....	1033	974	342	1208	114	32
Illinois	3,273	6.2	182	5	7	1671	78	1330	....	28
Michigan	3,196	6.0	....	....	144	1760	185	1107	....	31
Wisconsin	2,352	4.4	22	....	570	147	800	807	6	24
Vermont	2,024	3.8	....	....	1269	....	68	687	....	6
New Jersey	1,678	3.2	....	846	17	138	591	86	....	14
New York	1,590	3.0	13	4	1269	271	22	11	....	29
Indiana	1,228	2.3	....	....	25	762	56	385	....	15
All other states	1,132	2.1	8	....	719	222	38	145	....	30
United States	53,111	100.0	239	1024	15,313	20,749	5407	10,259	120	403

Machinery

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INDUSTRIAL ADVERTISING CONFERENCE

In connection with the convention of the Associated Advertising Clubs of the World to be held in Milwaukee, Wis., June 11 to 15, an industrial advertising conference will be held which will deal entirely with this class of advertising. In connection with this conference, there will be an exhibition of industrial advertising, which will include complete campaigns of general advertising, business paper advertising, letters, broadsides, folders, and catalogues as well as single advertisements. Individual photographs, drawings, and paintings for advertising purposes will add to the attractiveness of the exhibition. Those interested in this part of the work of the conference should communicate with A. K. Birch, advertising manager, Allis-Chalmers Mfg. Co., Milwaukee, Wis. The program for the industrial sessions, of which Keith J. Evans, advertising manager of Joseph T. Ryerson & Son, Chicago, Ill., is chairman, will include a great many papers of interest to industrial advertisers.

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MEETING OF THE AMERICAN SOCIETY FOR TESTING MATERIALS

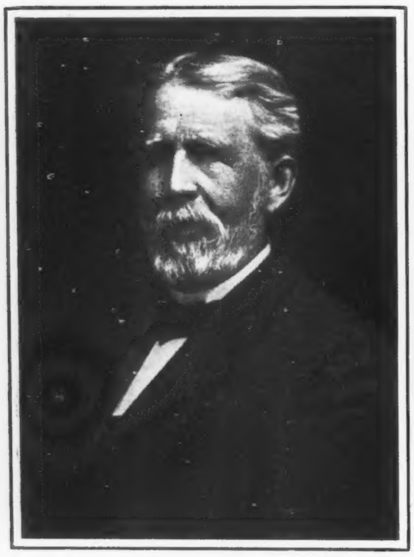
The twenty-fifth annual meeting of the American Society for Testing Materials will be held in Atlantic City, N. J., during the week of June 26. There will be twelve business sessions, at which a number of interesting subjects will be considered, among which are the following: Metallography and corrosion of non-ferrous metals; wrought, cast, and malleable iron; steel; impact testing of materials; and methods of testing fatigue of metals.

OBITUARIES

William A. Greaves, president of the Greaves Machine Tool Co., Cincinnati, Ohio, died April 18, aged sixty years. Mr. Greaves was born in Cincinnati, Ohio. In 1889 he organized the firm of Greaves-Klusman & Co., in association with H. H. Klusman, to manufacture lathes. Later he retired from this firm, and with his three sons organized the Greaves Machine Tool Co. in Cincinnati. He is survived by his widow and three sons.

J. Ryan, for eighteen years manager of the Paris office of the Potter & Johnston Machine Co., of Pawtucket, R. I., died on the first of last May. Mr. Ryan was a man of great energy, a skilled mechanic, with a wide acquaintance among French engineers, including government officials, which enabled him to place enormous orders for Potter & Johnston machines during the war, that firm being generally credited with having made the largest sales in France of any one type of machine tool. Mr. Ryan had been in failing health for over a year, and his death will be a great loss to the company with which he was connected for so long a time.

LAROY S. STARRETT



Laroy S. Starrett, president of the L. S. Starrett Co., Athol, Mass., died of pneumonia at his winter home in St. Petersburg, Fla., on April 23. He lived to within two days of his eighty-sixth birthday. Mr. Starrett was born in China, Me., on April 25, 1836. He was brought up on a farm and received his education in the country schools. His career was a remarkable one, starting among the hardest conditions of life and ending with marked success. At an early age he began to show a keen interest in the mechanical line, and was constantly busying himself with tools. When he was seventeen he left the farm and went to Newburyport, Mass., to work in a machine shop, and in 1866 he started his first machine shop in that town. In 1868 the Athol Machine Co. was established to manufacture his inventions. Mr. Starrett subsequently suffered reverses and lost control of that concern, but he was undaunted, and in 1880 began the manufacture of the well-known Starrett line of machinists' tools which has met with such marked success. He gradually built up a large business and later regained control of the Athol Machine Co. He also founded the Union Twist Drill Co. Mr. Starrett was a public-spirited man, and the prosperity of the town in which he lived was due, in a large measure, to his activities.

WILLIAM GLEASON

William Gleason, president of the Gleason Works, Rochester, N. Y., died at his home in Rochester, May 24. He was eighty-six years old, having been born in Tipperary County, Ireland, in 1836. He came to America at the age of fifteen, and served a machinist apprenticeship in Rochester. Later he went to Hartford, Conn., where he was employed in the Colt Armory during the Civil War. In 1865, Mr. Gleason returned to Rochester and opened a machine shop. Soon afterward he went into partnership with John Connell and James S. Graham under the name of Connell, Gleason & Graham, building machine tools and woodworking machinery. This partnership was dissolved in 1873 when Mr. Gleason went with the Kidd Iron Works, which he took over in 1875. Under the name of the Gleason Works the business has steadily grown from that time on, and wherever machine tools are used Mr. Gleason is known as the inventor of the bevel gear-cutting machines that bear his name. He was president of the Gleason Works up to the time of his death, although in his later years most of the business was administered by his sons, James E. and Andrew Gleason, who are vice-presidents. He is also survived by his wife and two daughters, Kate and Eleanor Gleason.

PERSONALS

Arthur Jenner, factory superintendent of the Noiseless Typewriter Co., Middletown, Conn., has resigned, and is planning to take a trip to Europe, returning about July 20.

Walter F. Rogers, of Southbridge, Mass., formerly with the Norton Co., Worcester, Mass., is now associated with the selling organization of the Reeves Pulley Co., Columbus, Ind.

Frank W. Adams, Jr., formerly western representative for C. E. Johansson, Inc., Poughkeepsie, N. Y., is now sales manager for the Steel Products Engineering Co., Springfield, Ohio.

John A. Johnson has been appointed works manager of the K. & F. Mfg. Co., 208 N. Wells St., Chicago, Ill., engineers and tool builders. Mr. Johnson has had a wide experience in the metal line.

L. S. Love, formerly vice-president and general manager of Barbour, Love & Woodward, New York City, has resigned his connection with that company. No announcement of Mr. Love's plans for the future has yet been made.

Malcolm Grant has joined the selling organization of the Black & Decker Mfg. Co., Towson Heights, Baltimore, Md., and will cover the state of Ohio, with the exception of the corner that takes in Cincinnati and Dayton. His headquarters will be at the Cleveland office, 2030 E. 22nd St.

Marvin E. Monk has been appointed assistant sales manager in charge of general sales of the U. S. Ball Bearing Mfg. Co., Chicago, Ill. Mr. Monk was formerly special sales engineer for Manning, Maxwell & Moore, Inc., of New York City. J. J. Torpey will continue as assistant sales manager in charge of bearing distributors.

R. M. Barwise who has been eastern representative of the Diamond Chain & Mfg. Co., Indianapolis, Ind., for the last twelve years, has opened an office and store-room at 18 Hudson St., near Reade, New York City. Mr. Barwise will act as distributor of Diamond chains, and of the gears and sprockets made by the Philadelphia Gear Works.

Carl G. Schluederberg, executive assistant to the manager of the supply department of the Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., has been elected president of the American Electro-Chemical Society. Mr. Schluederberg has been very active in American electro-chemical circles and has done considerable research work along these lines.

C. M. Hall, formerly in charge of the New York territory for the Dodge Transmission Co., has become associated with the Black & Decker Mfg. Co., Towson Heights, Baltimore, Md., and will have charge of the territory that includes Indiana, Kentucky, and that corner of Ohio that takes in Cincinnati and Dayton. Mr. Hall's headquarters will be in Indianapolis.

C. G. d'Ugglas, formerly assistant chief engineer with the Cleveland Machine & Mfg. Co., Cleveland, Ohio, is now associated with Williams, White & Co., Moline, Ill., in the capacity of assistant chief engineer in charge of the power press division. Mr. d'Ugglas is a mechanical engineer. He came to this country from Sweden about ten years ago, and has been connected most of the time since he has been here with the manufacture of power presses.

Joseph F. Keller, of Brooklyn, N. Y., was awarded the Edward Longstreth medal by the Franklin Institute at its April meeting, for his automatic die-cutting machine. This medal was also awarded to Samuel T. Freas, of Trenton, N. J., for an interlocking tooth saw, and to Charles F. Wallace and Martin F. Tiernan of the firm of Wallace & Tiernan, Newark, N. J., for their apparatus for the distribution of liquid chlorine for water purification.

J. Martin Duncan of the Detroit Steel Casting Co., Detroit, Mich., has been promoted to the position of general sales manager. Mr. Duncan's previous work has been that of following up every important shipment to its destination, to see how the castings were applied, and to ascertain whether more satisfactory results could be obtained by a closer cooperation between the management and the user. He is succeeded in this work by E. R. Young. Mr. Allen, formerly sales manager, is now assistant general manager.

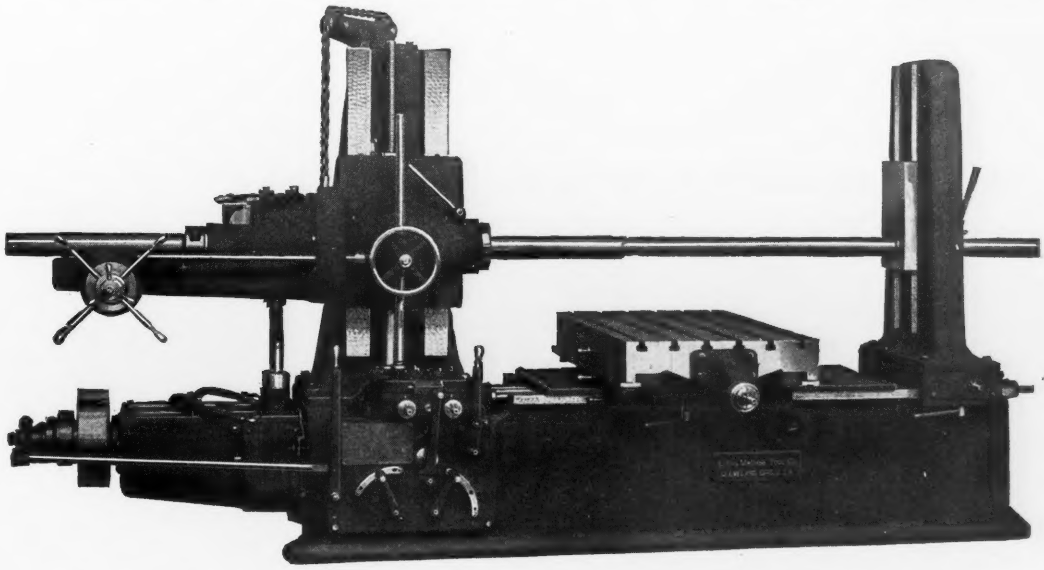
Ambrose Swasey, president of the Warner & Swasey Co., Cleveland, Ohio, was elected to membership in the National Academy of Sciences at the recent annual meeting in Washington. Members of the academy are grouped into committees of mathematics, astronomy, physics, engineering, chemistry, etc. The honor was conferred upon Mr. Swasey on account of his achievement and interest in the design and construction of great telescopes and other scientific instruments of precision. He established the Engineerinig Foundation and is an honorary member of a number of leading American and European scientific and engineering organizations, as well as an officer of the Legion of Honor of France. He is also a member of the National Research Council, which was organized in 1916 at the request of President Wilson, under the charter of the National Academy of Sciences.

Mr. MANAGER:

This is addressed to YOU.

A good many foremen and superintendents have told us that the men always prefer to use the

"Precision" BORING, DRILLING & Milling Machine



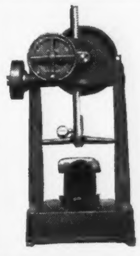
Why do the men prefer to use it? Because they want to *make a record,* and they can make it easier and quicker by using the *"Precision".*

The reason that they want to make a record is that they want to make *more money* and they know that they must make a record first.

A record by the man is also a record for the foreman and the superintendent, and a record for the works.

A record for the works is a record for the *manager* and the manager doesn't object to more money either.

It is up to the manager to buy the kind of machines that will allow the record to be made—the *Precision* is *it.*



WE ALSO MAKE THE

LUCAS POWER

Forcing Press

LUCAS MACHINE TOOL CO. NOW AND ALWAYS OF **CLEVELAND, OHIO, U.S.A.**

FOREIGN AGENTS: Alfred Herbert, Ltd., Coventry. Societe Anonyme Belge, Alfred Herbert, Brussels. Aux Forges de Vulcain, Paris. Allied Machinery Company, Turin, Barcelona, Zurich. Benson Brothers, Sydney, Melbourne. V. Lowener, Copenhagen, Christiania, Stockholm. R. S. Stokvis & Zonen, Rotterdam. Andrews & George Company, Tokyo, Japan.

COMING EVENTS

June 5-9—Annual convention and exhibit of the American Foundrymen's Association and allied societies in Rochester, N. Y. Secretary C. E. Hoyt, Marquette Bldg., 140 S. Dearborn St. Chicago, Ill.

June 14-21—Annual meeting of the Mechanical Division of the American Railway Association in Atlantic City, N. J. Secretary V. R. Hawthorne, 431 S. Dearborn St., Chicago, Ill.

June 15-24—International exhibition of foundry equipment and materials in Birmingham, England, in connection with the annual convention of the Institution of British Foundrymen.

June 20-24—Summer meeting of the Society of Automotive Engineers at White Sulphur Springs, W. Va. Chairman of Meetings Committee, C. F. Scott, 29 W. 39th St., New York City.

June 26-30—Twenty-fifth annual meeting of the American Society for Testing Materials in Atlantic City, N. J.; headquarters, Chalfonte-Haddon Hall Hotel. Secretary C. L. Warwick, 1315 Spruce St., Philadelphia, Pa.

August 28-September 2—Annual Safety Congress of the National Safety Council in Detroit, Mich. Secretary S. J. Williams, 168 N. Michigan Ave., Chicago, Ill.

September 11-16—Eighth national exposition of chemical industries in the Grand Central Palace, New York City. Managers, Charles F. Roth and Fred W. Payne, Grand Central Palace, 46th St. and Lexington Ave., New York City.

December 7-13—National Exposition of Power and Mechanical Engineering at the Grand Central Palace, New York City. Charles F. Roth, manager, Grand Central Palace, 46th St., and Lexington Ave., New York.

SOCIETIES, SCHOOLS AND COLLEGES

University of Delaware, Newark, Del. Annual catalogue for 1921-1922, containing calendar, courses of study, and other related information.

Clarkson College of Technology, Potsdam, N. Y. Catalogue for 1922, containing calendar for 1921-1922, courses of study, and other information relative to the college.

Polytechnic Institute of Brooklyn, Brooklyn, N. Y. Catalogue of the College of Engineering for 1922-1923, containing calendar, requirements for admission, description of courses, and schedules for both day and evening departments.

Ohio State University, Columbus, Ohio. Educational Research Bulletin No. 9, containing announcement of summer quarter courses offered in the College of Education, the first term of which begins on June 19 and the second on July 27.

NEW BOOKS AND PAMPHLETS

Cutting Fluids. By Eugene C. Bingham. 76 pages, 7 by 10 inches. Published by the Department of Commerce, Washington, D. C., as Technologic Paper No. 204 of the Bureau of Standards. Price, 15 cents.

An Investigation of the Properties of Chilled Iron Car Wheels. By J. M. Snodgrass and F. H. Guldner. 103 pages, 6 by 9 inches. Published by the Engineering Experiment Station of the University of Illinois, Urbana, Ill., as Bulletin No. 129.

Tensile Properties of Some Structural Alloy Steels at High Temperatures. By H. J. French. 92 pages, 7 by 10 inches. Published by the Department of Commerce, Washington, D. C., as Technologic Paper No. 205 of the Bureau of Standards. Price, 5 cents.

Some Effects of the Distributed Capacity between Inductance Coils and the Ground. By Gregory Breit. 7 pages, 7 by 10 inches. Published by the Department of Commerce, Washington, D. C., as Scientific Paper No. 427 of the Bureau of Standards. Price, 5 cents.

Manufacture and Properties of Steel Plates Containing Zirconium and other Elements. By George K. Burgess and Raymond W. Woodward. 54 pages, 7 by 10 inches. Published by the Department of Commerce, Washington, D. C., as Technologic Paper No. 207 of the Bureau of Standards. Price, 20 cents.

Report of the Engineering Foundation for the Year Ended February 9, 1922. 92 pages, 7 by 10 inches. Published by the Engineering Foundation, Engineering Societies Building, 29 W. 39th St., New York City, as Publication No. 4.

In addition to the report for the year contained in this publication, there is also a report of a research on the fatigue of metals, which is given in full, including diagrams and tables.

Construction of Radiophone and Telegraph Receivers for Beginners. By M. B. Sleeper. 142 pages, 5¼ by 7½ inches. Published by the Norman W. Henley Publishing Co., 2 W. 45th St., New York City. Price, 75 cents.

The widespread interest in wireless telephony has created a demand for books on this subject, especially for those containing instructions for amateurs who are building their own equipment. This book which is written for the beginner, gives directions for the construction of radiophone and telegraph receivers. Special receivers, both crystal and audion, are shown in detail. The material is illustrated by halftones, diagrams, and working drawings, which have been especially prepared for this book. The information covers the erection of antennas, planning a station, and building all kinds of crystal, audion and regenerative receivers, with amplifiers and "loud speakers" for receiving radio telephone broadcasting and telegraph signals.

The Iron Man in Industry. By Arthur Pound. 230 pages, 5½ by 8 inches. Published by the Atlantic Monthly Press, 8 Arlington St., Boston, Mass. Price, $1.75.

This is an interesting contribution to the literature on industrial problems. It points out the social significance of the automatic machine, which the author calls the "iron man," and the labor problems that have followed in its wake. The author has worked in factory towns at a trade, and has been both employer and employe, reporter, editor, and printer, so that he has had an opportunity to look at the problem of social unrest from more than one point of view. He begins his book with a study of industrial and social conditions in Flint, Mich., showing the effect of the automatic machine in the manufacturing center of the automobile industry. He then goes on to consider the problem in its national aspects. He points out the need for adapting present-day education to the march of civilization exemplified in the use of automatic machinery, and makes a plea for a better use of the leisure which the "iron man" has brought to the world.

Human Factors in Industry. By Harry Tipper. 280 pages, 5 by 7½ inches. Published by the Ronald Press Co., 20 Vesey St., New York City. Price, $2.

This book contains an analysis of the present situation relating to capital and labor and discusses many of the experiments that are being made with a view to obtaining better industrial conditions. The first part of the book contains an outline of the history of labor unions for the past century and discusses their present tendencies and prospects. Manufacturers' associations and the influence on modern industrial problems of recent developments in industrial, economic and political theory are also considered. Particular attention is given to the influence of the modern tendency toward specialization. The second part of the book treats of various remedial changes which are being tried, discusses incentives in industry, the wage system, bonuses and profit-sharing, the employment and industrial relations departments, employe representation, and the open shop issue. The book is the result of many years of intimate observation by the author in actual work with labor and in supervising all kinds of labor.

Metal Cutting Tools. By A. L. DeLeeuw. 328 pages, 6 by 9 inches. Published by the McGraw-Hill Book Co., Inc., New York City. Price, $3.

The object of this book is to set forth the principles which must be applied in the selection, design, maintenance and use of metal-cutting tools. It is primarily intended for the young engineer, student, foreman, time-setter, and particularly for the ambitious mechanic who is desirous of basing his skill on knowledge. The principles underlying the cutting action of metal-cutting tools are not yet absolutely established, but the material presented is based on numerous observations of the author and others. There are eighteen chapters dealing with the following subjects: Formation of Chips—Elementary Considerations in the Construction of Simple Tools; Consideration of the Element of Feed—Analysis of the Round-nosed Tool—Effect of Fundamentals of Cutting on Design; Various Types of Planer Tools; Standard Lathe Tools and Boring Mill Tools; Boring Tools; Single and Multiple Boring Tools—Reamers: Milling Cutters—Gear Cutters and Hobs; Cutter Sharpening; Form Tools; Shear Tools; the Use of Liquids when Cutting Metals; Generating Tools; Thread-cutting Tools; Hollow Mills, and Special Tools.

American Travel and Hotel Directory. 2008 pages, 6 by 9 inches; numerous illustrations. Published by the American Travel and Hotel Directory Co., Inc., Baltimore, Md. Sold by The Industrial Press, 140-148 Lafayette St., New York City. Price $10.

The 1922 edition of this well-known directory contains a vast amount of information of great value to everyone who travels for business purposes. It contains a complete list of all hotels in the United States, indicating the class of hotel, rates, etc., and also gives the same information for hotels in Canada and Latin America. In addition, it contains tables giving railroad fares and Pullman berth rates between the principal cities in the United States. The arrangement of the information in the book is very convenient. All states are arranged alphabetically, and under each state the cities and towns are also arranged in alphabetical order. A general description of the various states and cities, particularly from an industrial point of view, is given in this connection, and a list of local holidays for each state is included. This is a book that, when properly consulted and used, will easily save its cost several times over in the office of any firm or corporation that has sales and traveling men needing exact information, carefully condensed and classified. It makes it possible to reserve accommodations in advance at stated rates, and to plan business trips intelligently beforehand. In addition to the hotel directory, there is a brief description in connection with each city giving altitude, population, location, transportation facilities, telegraph, banking and express facilities, etc., and an outline of the principal industries.

NEW CATALOGUES AND CIRCULARS

Goddard & Goddard Co., Detroit, Mich. Folder entitled "A Statement," relating to the development of curved-back tooth milling cutters, as made by the company.

Kurtz Equipment Co., 57 W. Houston St., New York City. Circular advertising Kurtz trucks, casters, barrel racks, tiering machines, and other indoor handling equipment.

Heine Boiler Co., (formerly Heine Safety Boiler Co.), St. Louis, Mo. Pamphlet entitled "Forty Years of Progress," announcing a change in name and several new developments in boiler design.

R. S. Whitney Mfg. Co., 74 Nichols St., Lewiston, Me. Circulars illustrating and describing Whitney standard garage equipment, including arbor presses, automobile jacks, etc., and Whitney valve refacing lathe.

Griscom-Russell Co., 90 West St., New York City. Bulletin 360, describing the application of evaporators to the purification of boiler feed water by distillation, and illustrating the Reilly self-scaling evaporator.

Van Dorn & Dutton Co., Cleveland, Ohio. Leaflet treating of Van Dorn gears, containing information relative to the materials used and illustrations showing views in the gear-cutting and heat-treating departments.

Spencer Lens Co., Buffalo, N. Y. Catalogue covering the Spencer products for commercial and industrial laboratories, which inclpde projection apparatus, microscopes, photo-micrographic cameras, colorimeters, spectroscopes, photographic lenses, etc.

Nice Ball Bearing Co., Nicetown, Philadelphia, Pa. Catalogue giving dimensions and list prices of Nice annular type ball bearings, thrust bearings, and combination radial and thrust load ball bearings. Prices are also given for ball retainers and ball-bearing wheels.

Ingersoll-Rand Co., 11 Broadway, New York City. Bulletin 10004, descriptive of Type PO horizontal single-cylinder four-stroke cycle stationary oil engines. The features of construction are described in detail and data are given on fuel consumption, dimensions, etc.

N. A. Strand & Co., 625 W. Jackson Blvd., Chicago, Ill. Catalogue 22, covering the line of flexible shafts and equipment made by this concern. The equipment is applicable for grinding, polishing, sanding, drilling, reaming, tapping, tire-buffing, nut-setting, screw-driving, and many other operations.

Armstrong-Blum Mfg. Co., 343 N. Francisco Ave., Chicago, Ill. Catalogue 5, illustrating and describing the line of "Marvel" machines made by this concern, which includes high-speed sawing machines, hacksaws, band saws, punches and shears, drill press vises and combination punching, shearing, and bending machines.

Kearney & Trecker Corporation, Milwaukee, Wis. Circular illustrating Milwaukee milling machines and giving data on the saving in production costs effected in milling transmission cases, connecting-rods, cylinder blocks, and clutch adjusting rings, by the use of special attachments and fixtures designed for these machines.

Tide Water Oil Sales Corporation, 11 Broadway, New York City. Catalogue entitled "One Hundred and One Economies for the Motorist," containing information on the proper lubrication of all the different parts of automobiles. A diagram of a car is presented, on which is shown the location of every part that requires lubrication.

James Clark, Jr., Electric Co., Inc., Louisville, Ky., is issuing a monthly publication for the benefit of its selling agents and salesmen, known as the "Jasco Driller" which contains news relating to the activities and personnel of the firm, and information concerning its product, which comprises portable electric drills and other electrically driven tools.

Rochester Electric Products Corporation, Rochester, N. Y., has just issued the first of a series of pamphlets entitled "Little Motor Talks." Pamphlet 1 takes up the subject of brush mounting, and other features of motor design will be dealt with in subsequent issues. The company will be glad to place those interested in motors on its mailing list for the entire series.

Nilson-Miller Co., 1300 Hudson St., Hoboken, N. J. Card containing information on the gear-cutting service which this company is in a position to render, including the cutting of spur gears up to 66 inches in diameter, bevel gears up to 24 inches in diameter, helical gears up to 18 inches in diameter, internal gears up to 36 inches in diameter and worm-gear sprockets, intermittent gears, etc.

W. S. Rockwell Co., 50 Church St., New York City. Circular illustrating and describing Rockwell stationary and tilting crucible melting furnaces for aluminum, brass, bronze, copper, gold, monel metal, nickel, silver, and other non-ferrous

metals. These furnaces are operated with either oil or gas fuel. Dimensions are given covering the three sizes of stationary furnaces and the four sizes of tilting furnaces.

Turner Brass Works, Sycamore, Ill. Circular listing the principal points of construction in the Turner "Master" line of blow-torches, which may be used for burning either gasoline or kerosene. Particular attention has been given to safety features in the design of these torches. This line is an addition to the regular line of blow-torches made by this concern. List prices are given for the different sizes.

Scovell, Wellington & Co., Boston 9, Mass., accountants and engineers, have compiled a list of four hundred books on accountancy, industrial engineering, and related business topics. This list was prepared originally for the use of members of the company and clients, but is now being distributed without charge to those interested in buying business books on these subjects for their own use or for a commercial library.

Grindle Fuel Equipment Co., Harvey, Ill. General catalogue of Grindle powdered fuel equipment, pointing out the advantages of powdered fuel and the special features of the Grindle system. The catalogue contains many illustrations showing the Grindle powdered coal system, multiple-tube dryer, pneumatic conveying system, firing equipment, storage hoppers and tanks, etc. copies will be sent to those interested upon request.

General Tool & Equipment Co., 70 Monroe St., Chicago, Ill. Circular descriptive of the Sapihl portable electric grinder, which is especially adapted to valve grinding. The illustrations show some of the various uses of this tool in automobile shops and machine shops, for valve grinding, reamer and tool sharpening, surfacing, internal grinding, toolpost grinding, cutter grinding, and die work. Complete specifications for the tool are given.

Ingersoll Milling Machine Co., Rockford, Ill. Circular illustrating the use of the Ingersoll adjustable rotary milling machine in railroad shops for profile-milling such as, for example, milling the radius on the end of main rods, milling steel straps, side-rods, etc. The combination of the movements to the head, housing, table saddle and rotary table give the machine a wide range. Complete data for the various operations are given.

Newark Gear Cutting Machine Co., Newark, N. J. Catalogue 3, containing a detailed description of Newark spur gear cutting machines. The general description is followed by illustrations of the different types of machines and complete specifications, the specifications for each machine being given on the page opposite the illustration. The book concludes with tabular matter, relating to sizes and prices of involute gear cutters, instructions for sizing and cutting gears, and data on tooth parts.

W. J. Savage Co., Inc., Knoxville, Tenn. Circulars containing illustrations, descriptive material, and specifications covering the line of sheet-metal cutters made by this concern. These machines are made in four sizes—Nos. 0, 1, 2, and 3 for cutting stock up to 1/8, 3/16, 3/8, and 5/8 inch thick respectively. They are so designed that they will cut any shape out of sheets or plates and will finish inside angles, corners, or curves, in the same operation, thus eliminating torch-cutting, drilling, and hand work.

Condensite Co. of America, Bloomfield, N. J. Catalogue telling what condensite is and the many uses for which it is adapted. The illustrations show a variety of products made from this material. Catalogue entitled "Condensite in the Automotive Industry" showing the application of condensite to this particular field. On alternate pages are shown photographs of automobile parts made from this material, and on the opposite pages are brief statements pointing out the advantage of condensite for the parts shown.

Charles H. Besly & Co., 120-B N. Clinton St., Chicago, Ill. General catalogue of Besly grinding machines containing complete specifications and illustrations of the disk and ring-wheel single- and double-spindle grinders. These machines are of the ring-oiling type, and the construction of the ring-oiling spindle is illustrated and described in detail. All the single-spindle machines may be arranged for motor drive. Circular descriptive of the Besly "Titan Non-glaze" abrasive disks, which are made for use on Besly grinding machines.

Boston Gear Works, Norfolk Downs, Quincy, Mass. 1922 edition of general catalogue No. 40, covering 600,000 standardized Boston gears carried in stock in 1500 sizes. The latest addition of steel and iron internal gears for use with the company's new style pinions of less than twelve teeth are shown on pages 64 to 71. Complete data including dimensions, prices, etc., are given for brass, iron and steel bevel and spur gears, worm-gears, sprockets, etc. The catalogue also gives dimensions and prices of universal joints, ball bearings and thrust washers.

TRADE NOTES

J. Horstmann, dealer in machinery, tools, and steels, 81 Rue St. Maur, Paris, France, discontinued its New York office on May 15.

Acme Stamping & Machine Co., has reincorporated, and has changed its name to Acme Stamping & Mfg. Co. The firm is now located at 119 Sheldon St., Chicago, Ill.

Metal & Thermit Corporation, 120 Broadway, New York City, has removed its Pittsburg branch office from 1427 Western Ave. to 801 Hillsboro St., Corliss Station.

Alvord Reamer & Tool Co., Millersburg, Pa., manufacturer of reamers, milling cutters, twist drills, drop-forgings, punches and dies, and special tools, has moved its Philadelphia office to 228 Church St.

Reeves Pulley Co., Columbus, Ind., announces that the manufacture and sale of the Reeves centerless roll grinder will be carried on in the future from the office and factory of the company at Columbus, instead of through a sales agency as heretofore.

Sharon Pressed Steel Co., New York City, has moved its office from 66 Broadway to the company's new warehouse in the Dodge building, 47 West Broadway, corner of Murray St., where a complete line of trucks, trailers, skids, and other pressed steel products will be carried.

Arthur M. Watkins, dealer in machine tools, eastern agent for the Covington Machine Co., and New York agent for the American Tool Works Co.'s planers and the Ohio Machine Tool Co.'s shapers, has moved his offices from 165 Broadway to the Dodge Building, 53 Park Place, New York City.

General Tool & Equipment Co., 70 Monroe St., Chicago, Ill., has been appointed exclusive selling agent for the portable electric grinder made by the Sapihl Electric Tool Co., of Galesburg, Ill., in the states of Michigan, Ohio, Kentucky, Minnesota, North and South Dakota, Iowa, Indiana, Illinois and Pennsylvania.

Bristol Co., Waterbury, Conn., manufacturer of recording instruments, has opened a branch office at Philadelphia, in the Widener Bldg., Room 1311. C. C. Eagle, Jr., is in charge of the new office. Mr. Eagle has had wide experience, including laboratory training at the factory and sales training in the field. He was formerly in charge of the Detroit office.

Reeve-Fritts Co., 37 S. DesPlaines St., Chicago, Ill., has been formed for the purpose of dealing in new and second-hand machine tools. The officers of the company are J. E. Fritts, president and treasurer, and H. J. Reeve, vice-president and secretary. Both Mr. Fritts and Mr. Reeve were formerly associated with the Stocker-Rumely-Wachs Co. of Chicago.

Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., has recently erected a new building in Huntington, W. Va., at Second Ave. and Ninth St. The building is a three-story structure containing 30,000 square feet of floor space. The activities of the sales, service, and warehouse departments have been coordinated in the new building, and this, together with the better facilities provided, is expected to result in more effective service to customers.

Herberts Machinery & Supply Co., corner of Third and San Pedro Sts., Los Angeles, and 140 First St., San Francisco, Cal., dealer in machine tools and woodworking machinery, has been appointed exclusive representative for California, Arizona and Nevada for the Norton line of grinding machines, built by the Norton Co., Worcester, Mass. The Herberts Machinery & Supply Co. has placed an order for two carloads of grinding machines with the Norton Co. for stock purposes, which will enable them to take care of their trade by giving immediate delivery.

Oneonta Iron Works, Inc., Oneonta, N. Y., have recently opened the foundry previously operated by the Titchener Culver Iron Works, and will do a general jobbing business. A cupola with a capacity of from 6 to 7 tons has been installed. The officers of the concern are as follows: President, F. G. Schifferdecker; vice-president and general manager, R. S. Findlay. Mr. Findlay has been general foreman of the Hudson Coal Co.'s repair shops at Scranton, Pa., for the last four years, and previous to that time was engaged for a number of years on river harbor improvements for the United States Government.

Dodge Sales & Engineering Co., Mishawaka, Ind., manufacturer of power transmission appliances and heavy oil engines, has removed its New York City branch from 21 Murray St., to the Dodge Building at 53 Park Place, New York City. The new Dodge building is twelve stories high and is of steel and concrete construction. This company has maintained a branch and warehouse in New York City for over twenty-eight years, and in moving to its new location, which is convenient to shipping and railway facilities, will be in a position to handle more efficiently its local and export business.

Modern Machine Tool Co., Jackson, Mich., has taken over from the Sprague-Hayes Mfg. Co., of Detroit, Mich., the manufacture of a special combination table and vise for use on drilling machines. This device will now be manufactured by the Modern Machine Tool Co. on a royalty basis, under license from the inventor, George H. Cocks of Adrian, Mich. With the manufacturing rights, the Modern Machine Tool Co. acquired the tools, patterns, jigs, fixtures, etc., and also the stock of raw materials and finished table-vises which the Sprague-Hayes Mfg. Co. had on hand.

Arrow Tool & Mfg. Co., 200 Cannon St., Bridgeport Conn., has changed its name to the **Forsberg Mfg. Co.** This change was made because another company, which has been in business for a longer period of time, uses the word "Arrow" in its name and trademark. The Forsberg Mfg. Co. will continue to make tools and special machinery of all kinds. An up-to-date press room has been added to the plant, and the company is prepared to make stampings and sheet-metal specialties of steel, brass, aluminum, or other metals, in large quantities. In addition it is making a complete line of hacksaw frames. No change will be made either in the ownership or management.

General Electric Co., Syracuse, N. Y., announces a number of important changes in the directorate of the company: C. A. Coffin has retired as chairman of the board of directors and has been succeeded by Owen D. Young, who has been a vice-president of the company for many years. Gerard Swope, president of the International General Electric Co., has been elected president, succeeding E. W. Rice, Jr., who will devote his entire energy to the further upbuilding of the scientific, engineering, and technical phases of the company's work, and who will become honorary chairman of the board of directors. Anson W. Burchard, for many years vice-president of the company in charge of public utilities and foreign investment, was elected vice-chairman of the board. J. R. Lovejoy and G. F. Morrison were elected directors.

STATEMENT OF THE OWNERSHIP, MANAGEMENT, ETC., REQUIRED BY THE ACT OF CONGRESS OF AUGUST 24, 1912

of MACHINERY, published monthly at New York, N. Y., for April 1, 1922.

State of New York }
County of New York } ss.

Before me, a Notary Public in and for the state and county aforesaid, personally appeared Matthew J. O'Neill, who, having been duly sworn according to law, deposes and says that he is the treasurer and general manager of the Industrial Press, Publishers of MACHINERY, and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management, etc., of the aforesaid publication for the date shown in the above caption, required by the act of August 24, 1912, embodied in section 443, Postal Laws and Regulations, printed on the reverse of this form, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business managers are: Publisher, The Industrial Press, 140-148 Lafayette St., New York; Editor, Erik Oberg, 140-148 Lafayette St., New York; Managing Editor, None; Business Managers, Alexander Luchars, President, 140-148 Lafayette St., New York, and Matthew J. O'Neill, Treasurer and General Manager, 140-148 Lafayette St., New York.

2. That the owners of 1 per cent or more of the total amount of stock are: The Industrial Press; Alexander Luchars; Alexander Luchars, Trustee for Helen L. Ketchum, Elizabeth Y. Urban, and Robert B. Luchars; Matthew J. O'Neill; Louis Pelletier; and Erik Oberg. The address of all the foregoing is 140-148 Lafayette St., New York.

3. That there are no bondholders, mortgagees, or other security holders.

4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

MATTHEW J. O'NEILL, General Manager

Sworn to and subscribed before me this 17th day of March, 1922.

WILLIAM E. BACON,
(SEAL) Notary Public, Kings County No. 444
Kings Register No. 8109
New York County No. 79 New York Register No. 3047
(My commission expires March 30, 1923.)